Customer Care Solutions
Technical Documentation

# *SERVICE MANUAL*

[NMP Part No. 0275599]

# NHL-2NA Imaging Phone
# Nokia 7650

**NHL-2NA Issue 1: 07/2002**

NOKIA

# Customer Care Solutions
# Technical Documentation

## Amendment Record Sheet

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|---|---|---|---|
| | 07/2002 | OJ, JoM, VKa, MBe | Original Issue 1 |
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# Customer Care Solutions
# Technical Documentation

## NHL-2NA Overall Manual Contents

Contents:

# Customer Care Solutions
# Technical Documentation

## IMPORTANT

**This document is intended for use by qualified service personnel only.**

## Company Policy

Our policy is of continuous development; details of all technical modifications will be included with service bulletins.

While every endeavour has been made to ensure the accuracy of this document, some errors may exist. If any errors are found by the reader, NOKIA CORPORATION. should be notified in writing.

Please state:

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Latest Amendment Number (if applicable)

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## Warnings and Cautions

Please refer to the phone's user guide for instructions relating to operation, care and maintenance including important safety information.

Note also the following:

### Warnings:

1. CARE MUST BE TAKEN ON INSTALLATION IN VEHICLES FITTED WITH ELECTRONIC ENGINE MANAGEMENT SYSTEMS AND ANTI-SKID BRAKING SYSTEMS. UNDER CERTAIN FAULT CONDITIONS, EMITTED RF ENERGY CAN AFFECT THEIR OPERATION. IF NECESSARY, CONSULT THE VEHICLE DEALER/MANUFACTURER TO DETERMINE THE IMMUNITY OF VEHICLE ELECTRONIC SYSTEMS TO RF ENERGY.
2. THE HANDPORTABLE TELEPHONE MUST NOT BE OPERATED IN AREAS LIKELY TO CONTAIN POTENTIALLY EXPLOSIVE ATMOSPHERES EG PETROL STATIONS (SERVICE STATIONS), BLASTING AREAS ETC.
3. OPERATION OF ANY RADIO TRANSMITTING EQUIPMENT, INCLUDING CELLULAR TELEPHONES, MAY INTERFERE WITH THE FUNCTIONALITY OF INADEQUATELY PROTECTED MEDICAL DEVICES. CONSULT A PHYSICIAN OR THE MANUFACTURER OF THE MEDICAL DEVICE IF YOU HAVE ANY QUESTIONS. OTHER ELECTRONIC EQUIPMENT MAY ALSO BE SUBJECT TO INTERFERENCE.

### Cautions:

1. Servicing and alignment must be undertaken by qualified personnel only.
2. Ensure all work is carried out at an anti-static workstation and that an anti-static wrist strap is worn.
3. Ensure solder, wire, or foreign matter does not enter the telephone as damage may result.
4. Use only approved components as specified in the parts list.
5. Ensure all components, modules screws and insulators are correctly re-fitted after servicing and alignment. Ensure all cables and wires are repositioned correctly.

## ESD Protection

Nokia requires that phone repair places have sufficient ESD protection (against static electricity) when servicing cellular phones.

A cellular phone, which is ready for use, can be handled normally without ESD protection. The SIM card and battery can be replaced in normal conditions of use.

To replace the color cover ESD protection must be applied, except for the phone covers which can be replaced by the customer.

All electronic parts of the phone, including the display, are susceptible to ESD. Resistors, too, can be damaged by static electricity discharge.

All ESD sensitive parts must be packed in metallized protective bags during shipping and handling outside any ESD Protected Area (EPA).

Every repair action involving opening the phone or handling the phone components must be done under ESD protection.

ESD protected spare part packages MUST NOT be opened/closed out of an EPA.

For more detailed information about ESD protection and EPA, contact your local Nokia After Market Services representative.

# General Information

 

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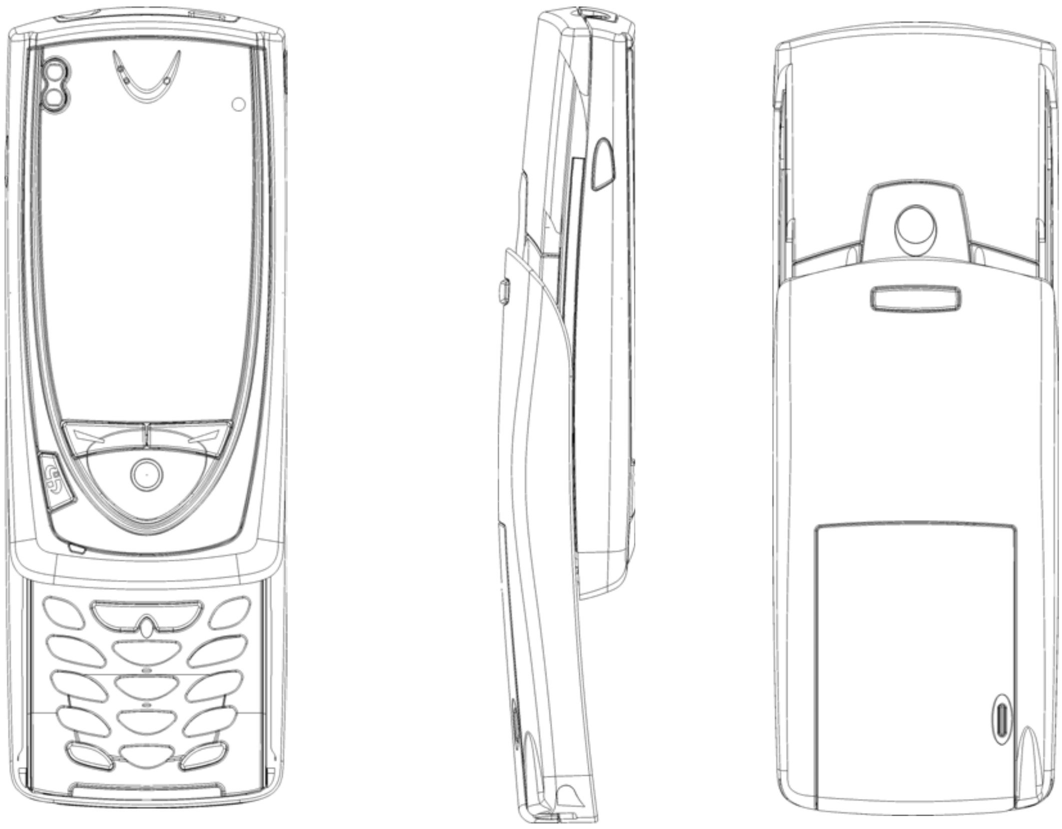
# Product Selection

## Handportables

The NHL-2NA  (Nokia 7650) is a handportable mobile imaging telephone for GSM900/GSM1800 and EGSM900/GSM1800 networks.

**Figure 1: NHL-2NA Phone, slide opened**



| Item | Name: | Type code: | Material code: |
|---|---|---|---|
| 1. | Transceiver | NHL-2NA | (See variant Appendices) |

# Product and Module List

Product:

| Unit/type: | **Type des.** | Code: |
|---|---|---|
| Transceiver | NHL-2NA* | 0630369 |
| Battery 750 mAh Li-Ion | BLB-2 | 0670246 |

For further information refer to section Product Variants of this manual.

Modules

The NHL-2NA consist of a Main Module LG4 (Display, Main PWB, RF, Navigation Key , BLUETOOTH, Audio etc) and a Grip Module LS4 which includes Battery, Keyboard, Charger connector and Vibra. These two parts are connected together through Flex.

ITU-T variant modules are listed below

| Transceiver NHL-2NA: | Sub-assembly | **Module type.** | Code: | **Note** |
|---|---|---|---|---|
| Grip module | | LS4 | 0257003 | ITU-T keyboard variant |
| | PWB module | LS4 | 0201711 | |
| | Assembly parts | MLS4 | 0262595 | Not a spare part |
| RF/BB module | | LG4 | 0201707 | |
| | Grip flex module | L4 | 0201759 | Hot bar soldered to LG4 |
| | Assembly parts | MLG4 | | Not a spare part |

For more information about modules refer to sections System module and User Interface of this service manual.

# General Specifications of NHL-2NA

## Mechanical Dimensions

| Unit | Dimensions (W x H x D) (mm) | Weight (g) Typ. | Volume (cc) | Notes |
|---|---|---|---|---|
| Transceiver with BLB-2 Li-Ion battery | 57 x 115 x 26 | 155 | 138 | |

## Operating time

| Talk time with standard battery | Data call (HSCSD 2+2) talk time with standard battery | Standby time | Charging time with ACP-12 |
|---|---|---|---|
| 2 to 6 h | 2h to 4h | 7 d<br>(without BT connection) | 1h 25 min |

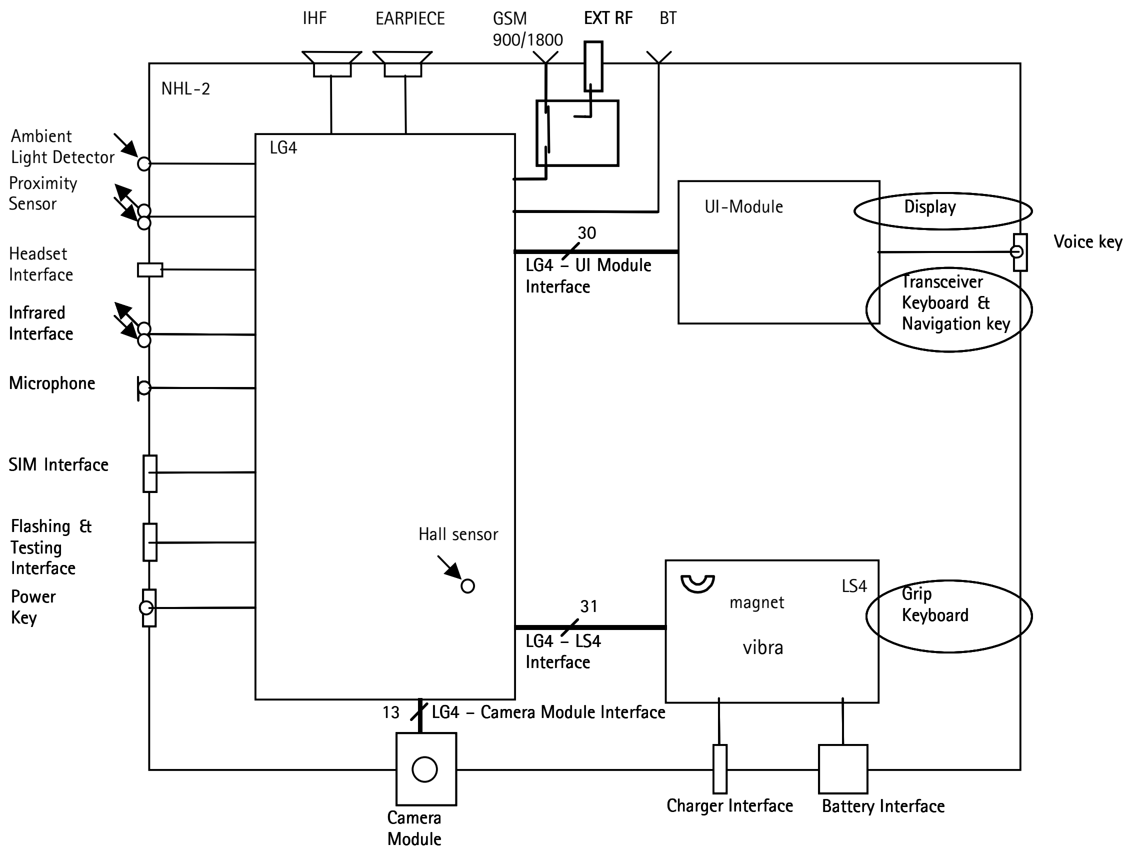
Figures mentioned above are approximate and depend on circumstances.

## Transceiver

| Parameter | Unit |
|---|---|
| **Cellular system** | **EGSM900 and GSM1800** |
| **RX frequency band** | **EGSM: 925 ... 960 MHz<br>GSM900 935 ... 960 MHz<br>GSM1805 ... 1880 MHz** |
| **TX frequency band** | **EGSM 880 ... 890 MHz<br>GSM900 890 ... 915 MHz<br>GSM1800 1710 ... 1785 MHz** |
| **Output power** | **GSM900 * +5 ...+33 dBm / 3.2 mW ... 2 W<br>GSM1800 +0 ...+30 dBm / 1.0 mW ... 1 W** |
| **Duplex spacing** | **GSM900 * 45 MHz GSM1800 95 MHz** |
| **Number of RF channels** | **EGSM 50<br>GSM900 174<br>GSM1800 374** |
| **Channel spacing** | **200 kHz** |
| **Number of TX power levels** | **GSM900 * 15 GSM1800 16** |

## Interconnection Diagram

**Figure 2: NHL-2NA interconnection diagram**




## Features

### Display and user interface

- Illuminated full graphic colour display

- Graphical user interface

- Joystick with 5-way navigation

### Memory

- 4MB dynamic memory for images, phonebook, calendar, messages, add-on applications

### Integrated digital camera

- Resolution 640x480

- Phone display used as viewfinder

- Photo album

**Wireless connectivity**

- IR link
- Bluetooth RF interface
- Wirelessly phone to phone or phone to PC
- Send/receive pictures, graphics, play games

**Operating system**

- Symbian OS

**Messaging, data**

- GPRS (up to 64.2 kbits/sec, 21.4 kbit/s per timeslot)
- HSCSDC (up to 43.2 kbits/sec
- Email protocols: STMP, POP3, IMAP4, POP3-SSL/TLS, IMAP4-SSL/TLS
- WAP 1.2.1

**Voice features**

- Voice dialling
- Voice recorder
- Integrated handsfree speaker

# Accessories

| Accessories, Unit/type: | **Type des.** | Code: |
|---|---|---|
| Battery, Li-Ion | BLB-2 | several variants |
| PC connectivity SW | | |
| Other Accessories, Unit/type: | **Type des.** | Code: |
| Desk Stand | DCC-1 | 0675288 |
| Double Mono Headset | HDD-1 | 0694066 |
| Headset with remote control | HDC-5 | 0694059 |
| Stereo Headset | HDE-2 | 0694075 |
| Mobile inductive loopset | LPS-3 | 0630244 |
| Carrying case | | |
| **Chargers, Unit/type:** | **Type des.** | **Code:** |
| Performance Travel Charger (EUR) 90-264 Vac | ACP-8E | 0675195 |
| Performance Travel Charger (US) 90-264 Vac | ACP-8U | 0675196 |
| Performance Travel Charger (ARG) 90-264 Vac | ACP-8AR | 0675248 |
| Fast Travel Charger (EUR) 90-264 Vac | ACP-9E | 0675149 |
| Fast Travel Charger (EUR) 90-264 Vac | ACP-9U | 0675151 |
| Fast Travel Charger (EUR) 90-264 Vac | ACP-9X | 0675150 |
| Fast Travel Charger (EUR) 90-264 Vac | ACP-9A | 0675152 |
| Fast Travel Charger (EUR) 90-264 Vac | ACP-12 | |
| Cigarette Lighter Charger | LCH-9 | 0675120 |

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# System Module LG4 and Grip Module LS4

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Table of Schematic Diagrams

# Abbreviations

| | |
|---|---|
| ADC | Analog-Digital Converter |
| AEM | Auxiliary Energy Management ASIC |
| AFC | Automatic Frequency Control |
| ALG | Ambient Light Guide |
| ALS | Ambient Light Sensor |
| ARM | Processor architecture |
| ASIC | Application Specific Integrated Circuit |
| BB | Baseband |
| BLUETOOTH, BT | Bluetooth |
| BSI | Battery Size Indicator |
| CBus | Control Bus connecting UPP_WD2 with AEM and UEM |
| CCI | Camera Control Interface |
| CCP | Compact Camera Port |
| CMT | Cellular Mobile Telephone (MCU and DSP) |
| CPU | Central Processing Unit |
| CSP | Chip Scale Package |
| CTSI | Clocking Timing Sleep Interrupt |
| DAC | Digital-Analog Converter |
| DAI | Digital Audio Interface |
| DBUS | Data Bus |
| DCN | Offset Cancellation contol signal |
| DIF | Display InterFace |
| DLL | Dynamic Link Library |
| DRC | Dynamic Range Controller |
| DSP | Digital Signal Processor |
| EFR | Enhanced Full Rate |
| EGSM | Extended – GSM |
| EQ | Equalizer |
| EXT RF | External RF |
| GPRS | General Packet Radio Service |
| GSM | Groupe Special Mobile/Global system mobile |
| HF | Hands free |
| HFCM | Handsfree Common |
| HS | Handset |
| HSCSD | High Speed Circuit Switched Data |
| I/O | Input/Output |
| IHF | Integrated hands free |
| IC | Integrated Circuit |
| IR | Infra red |
| IRED | InfraRed Emitting Diode |
| IrDA | Infrared Association |
| LCD | Liquid Crystal Display |
| LG4 | NHL-2NA Main PWB module |
| LNA | Low Noise Amplifier |
| MCU | Micro Controller Unit |
| MIC, mic | Microphone |
| PA | Transmit Power Amplifier |

| | |
|---|---|
| PC | Personal Computer |
| PDA | Pocket Data Application |
| PWB | Printed Wiring Board |
| RF | Radio Frequency |
| RFBUS | Control Bus For RF |
| SDRAM | Synchronous Dynamic Random Access Memory |
| SIM | Subscriber Identity Module |
| UI | User Interface |
| UEM | Universal Enefry Management |
| VGA | Video Graphic Array |
| VCXO | Voltage Controlled Crystal Oscillator |
| VCTCXO | Voltage Controlled Temperature Compensated Crystal Oscillator. |
| VCM | Voltage Controlled Module |
| VGA | Video Graphics Array |

# LG4 System Module

## Introduction

This is the module specification of LG4 which is the main electronics module in NHL-2NA GSM dual band phone. NHL-2NA phone is also nick named as Nokia 7650. The sales name is Nokia 7650.

# Technical overview

## LG4 features

- Dual band GSM tranceiver. EGSM900 and GSM1800 bands with GPRS class 6 and HSCSD data capability
- BB release is Galaxy WD2, main ASIC UPP_WD2
- RF release is Gemini premium release for Lilly (but shrinked)
- Bluetooth, based on BT102 module
- IR, HW capable for 1Mbit data speed
- Proximity sensor for controlling integrated handsfree feature (IHF)
- Handsfree, headset and earpiece audio connections
- VGA camera module connected with spring connector to LG4
- Ambient light sensor for controlling display and keyboard backlights
- Color display interface
- Flex cable interface to LS4 Grip module

## Component placement and PWB outline

Components are placed only on one side of the LG4 module.

Figure 1 shows LG4 module from component side, main components are listed.

**Figure 1: Main components on LG4**

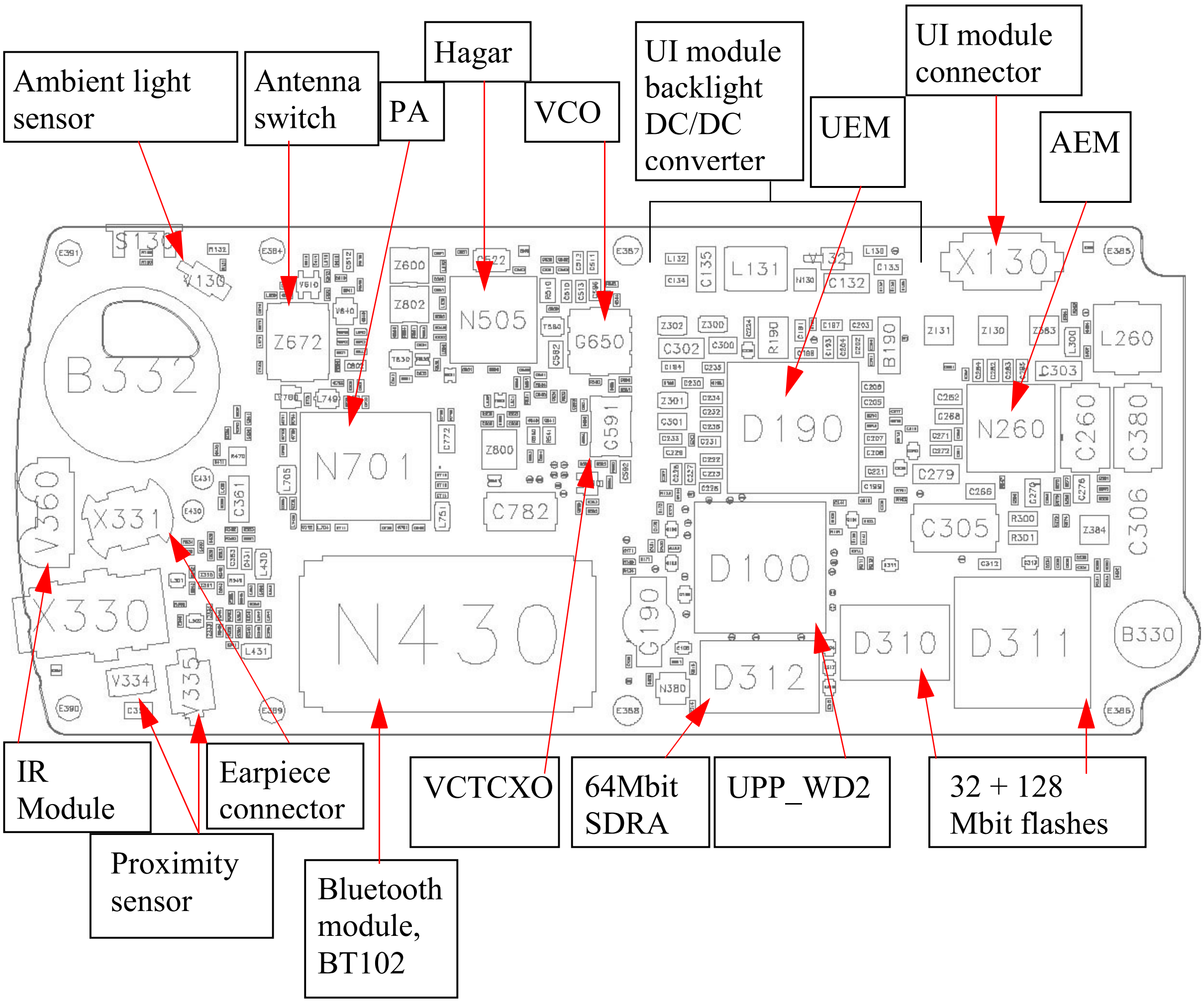


Figure 2: Spring connection pads on top side of LG4

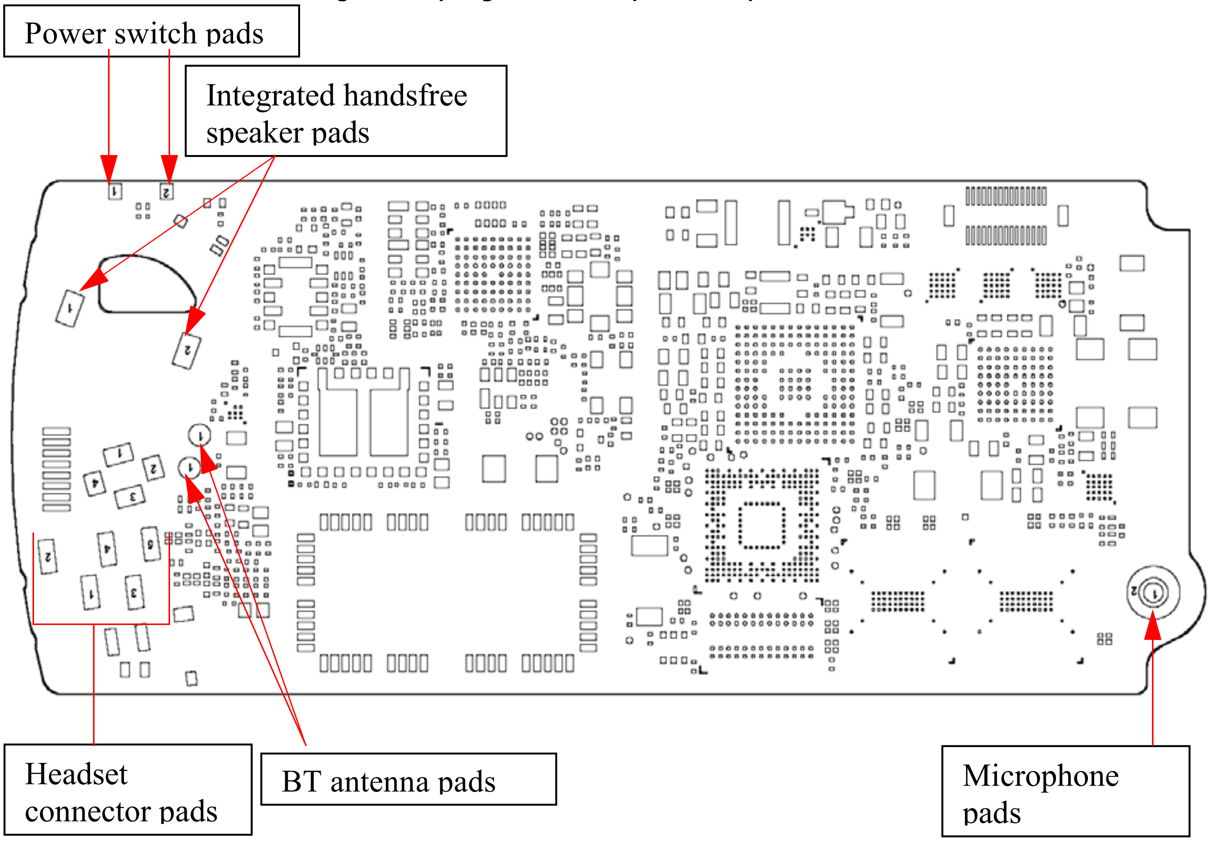



Figure 3: Spring connection pads on back side of LG4 and flex cable solder pads

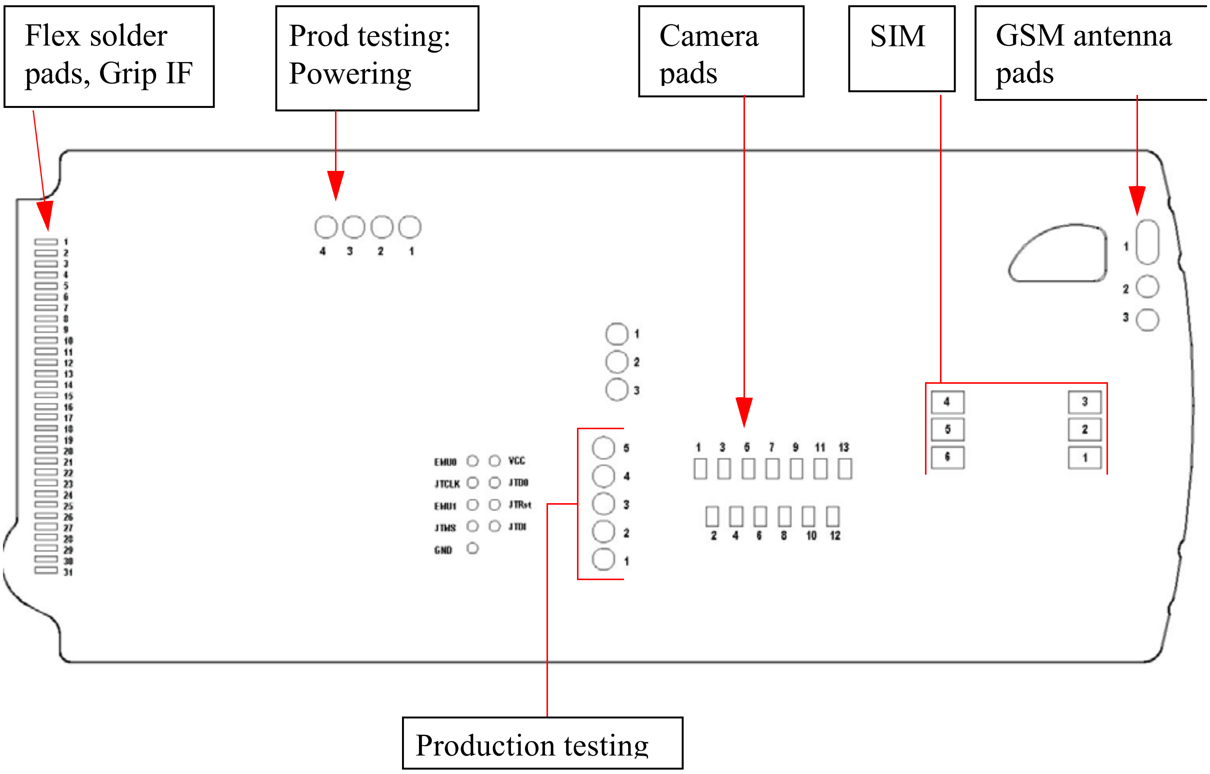
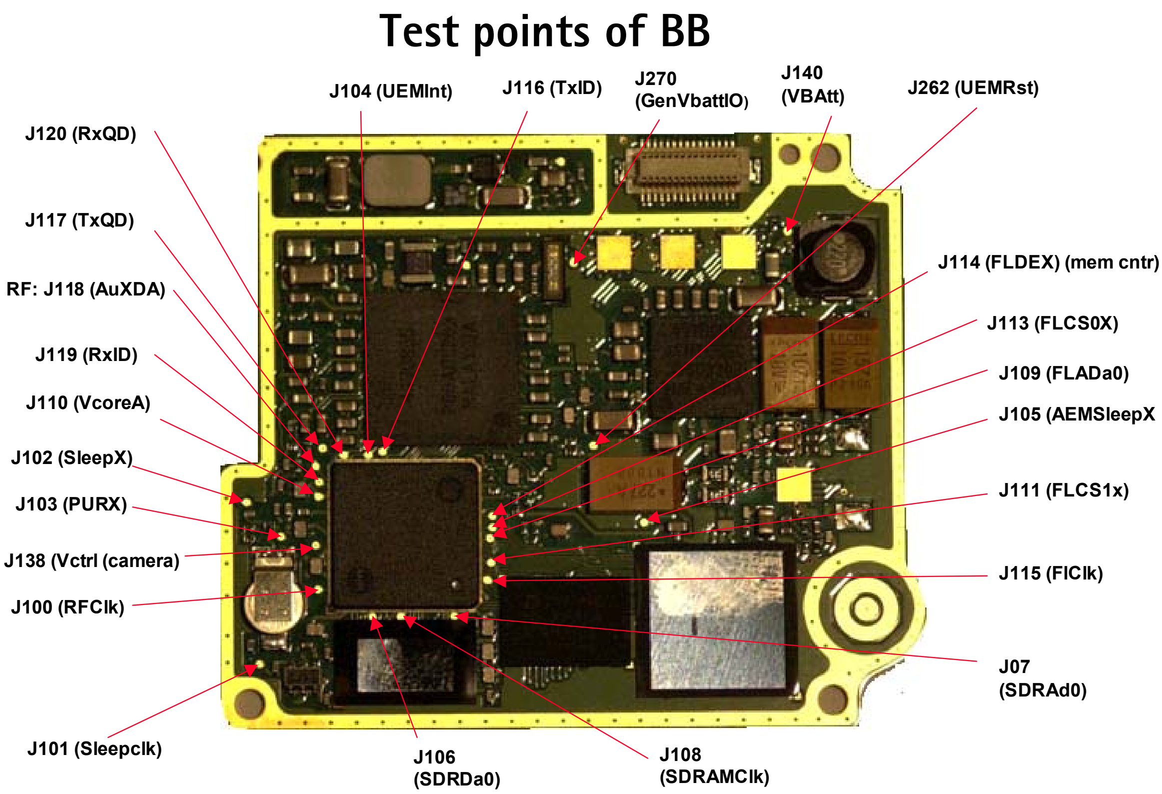


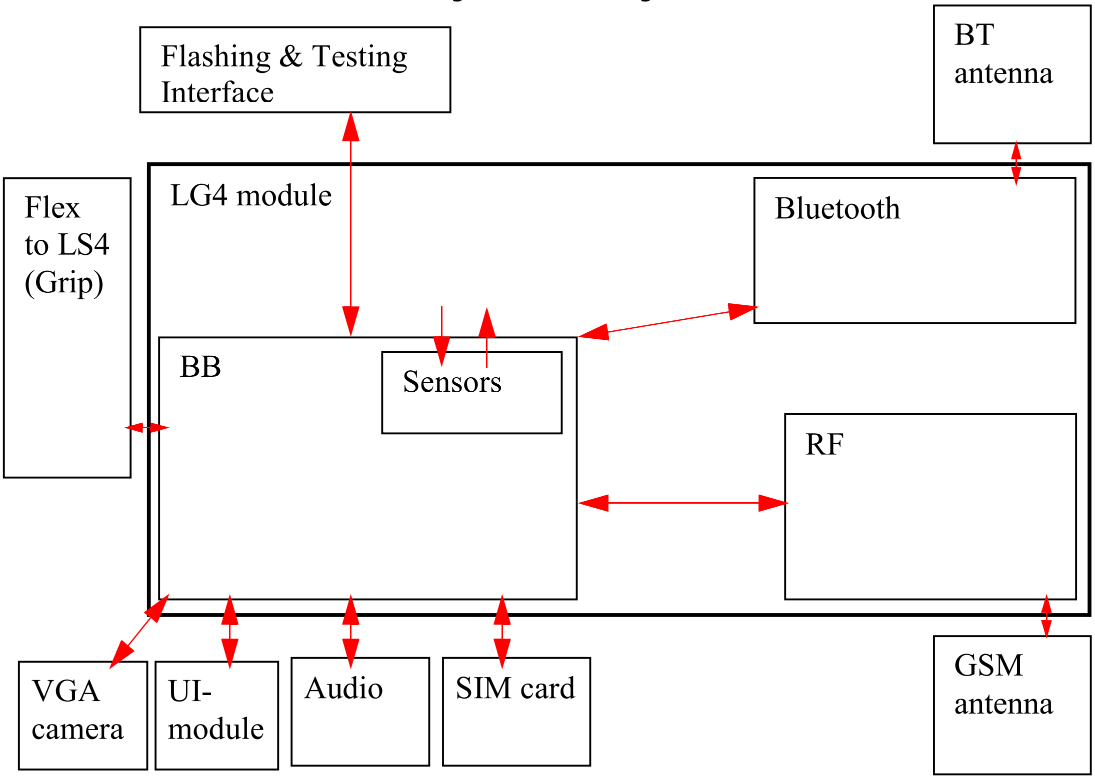
Figure 4: Test points in LG4 baseband



# Block diagram

Below is the block diagram of LG4 module. External interfaces are drawn as arrows crossing LG4 border.

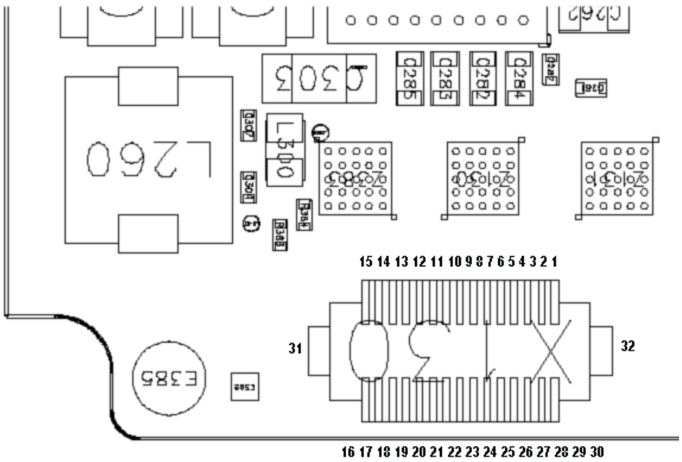
Figure 5: Block diagram of LG4




## UI Interface

UI module interface pin numbering is presented in figure below. UI interface details are in UI-module specification.

Figure 6: UI connector pin numbering on LG4 side



# Baseband Technical Summary

The heart of the BB is UPP_WD2, which includes MCU, DSP and Digital Control Logic. Powering handled by Using AEM ASIC and UEM ASIC. There is Flash Memory 128Mbit + 32Mbit Flashes (20 Mbytes) and 64 Mbit (8 Mbytes) SDRAM. So there is a total of 28 Mbytes of Memory Capacity.

In BB there is an integrated Handsfree Audio Amplifier In AEM. There are two Audio Elements (Earpiece 8 mm and Speaker 16 mm) and External Galvanic Headset (DCT4) interface. IHF Speaker is also used to handle the Ringing tone. For IHF automated off function there is proximity Sensor. In NHL-2NA there is only one microphone for both modes HS and IHF.

For Data connectivity there is 1Mbit IR Module (IrDA compatible) and Bluetooth.

Display is MD-TFD type Color Display with 4096 Colors and 176x208 pixels with Backlight. Keyboard is partially in UI-Module and Partially in Grip-Module. Also there is This Navigation Key Feature in UI-Module.

For imaging purposes BB supports VGA camera via CCP interfaces, which are integrated in UPP_WD2.

# Functional Description

## BB Description

Core is based on UPP_WD2 CPU, which is a special version of the DCT4 UPP ASIC. UPP_WD2 takes care of all the signal processing and operation controlling tasks of the phone as well as all PDA tasks.

For Power management there are two Asics for controlling energy management and supplying current and different voltages; UEM and AEM. UEM and SW have the main control of the system voltages and operating modes and AEM acts as an auxiliary source of voltages and current. The main reset for the system is generated by the UEM.

The interface from the RF and audio sections is handled also by UEM. This ASIC provides A/D and D/A conversion of the in-phase and quadrature receive and transmit signal paths and also A/D and D/A conversions of received and transmitted audio signals. Data transmission between the UEM, AEM and RF and the UPP_WD2 is implemented using different serial connections (CBUS, DBUS and RFBUS). Digital speech processing is handled by UPP_WD2 ASIC. Internal HF with proximity sensor functionality is implemented inside the AEM ASIC.

A real time clock function is integrated into UEM, which utilizes the same 32kHz-clock source as the sleep clock. A rechargeable battery provides backup power to run the RTC when the main battery is removed. Backuptime is 20 Hours.

### Memory Configuration

NHL-2NA uses two kinds of memories, Flash and SDRAM. These Memories have their own Dedicated buses in UPP_WD2.

Synchronous DRAM is used as working memory. Interface is 16 bit wide data and 14 bit Address. Memory clocking speed is 104 MHz. The SDRAM size 64Mbits (4Mx16).

SDRAM I/O is 1.8 V and core 2.78 V supplied by AEM's regulators VIOA and VMEMA. All memory contents are lost if the supply voltage is switched off.

Multiplexed Flash Memory Interface is used to store the MCU program code and User Data. The memory interface is a burst type FLASH with multiplexed address/data bus.

Both I/O and core voltage are 1.8 V supplied by AEM's VMEMB.

### Energy Management

The master of EM control is UEM and with SW they have the main control of the system voltages and operating modes. AEM (Auxiliary Energy Management) acts as an auxiliary source of voltages and current.

## Modes of Operation

NHL-2NA employs several hardware & SW controlled operation modes. Main Modes are described below.

- NO_SUPPLY mode means that the main battery is not present or its voltage is too low (below UEM master reset threshold) and back-up battery voltage is too low.
- In BACK_UP mode the main battery is not present or its voltage is too low but back-up battery has sufficient charge in it.
- In PWR_OFF mode the main battery is present and its voltage is over UEM master reset threshold. All regulators are disabled.
- RESET mode is a synonym for start-up sequence and contains in fact several modes. In this mode regulators and oscillators are enabled and after they have stabilized system reset is released and PWR_ON mode entered.
- In PWR_ON mode SW is running and controlling the system.
- SLEEP mode is entered from PWR_ON mode when the system's activity is low (SLEEPX and AEMSLEEPX controlled by SW).
- FLASHING mode is for production SW download.

### Voltage limits

In the following the voltage limits of the system are listed. These are also controlling system states.:

| Parameter | Description | Value |
|---|---|---|
| $V_{MSTR+}$ | Master reset threshold (rising) | 2.1 V (typ.) |
| $V_{MSTR-}$ | Master reset threshold (falling) | 1.9 V (typ.) |
| $V_{COFF+}$ | Hardware cutoff (rising) | 3.1 V (typ.) |
| $V_{COFF-}$ | Hardware cutoff (falling) | 2.8 V (typ.) |
| $V\_BU_{COFF+}$ | Back-up battery cutoff (rising) | 2.1 V (typ.) |
| $V\_BU_{COFF-}$ | Back-up battery cutoff (falling) | 2.0 V (typ.) |
| $SW_{COFF}$ | SW cutoff limit (> regulator drop-out limit) MIN! | *3.15 V* SW changeable |

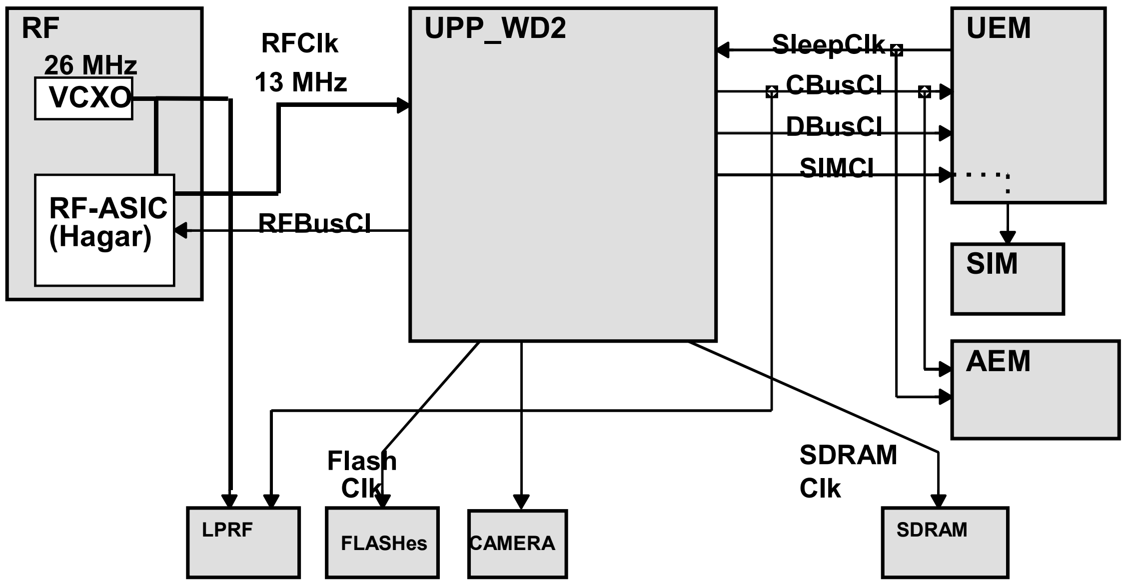
The master reset threshold controls the internal reset of UEM. If battery voltage is above $V_{MSTR}$, UEM's charging control logic is alive. Also, RTC is active and supplied from the main battery. Above $V_{MSTR}$ UEM allows the system to be powered on although this may not succeed due to voltage drops during start-up. SW can also consider battery voltage too low for operation and power down the system.

## Clocking Scheme

A 26 MHz VCTCXO is used as system clock generator in GSM. During the system start-up, UEM and AEM use their own RC-oscillators to generate timing for state machines. All clock signals of the engine are illustrated in following figure.

In PWR_ON mode, SW must configure CBUS clock (1MHz) to be active all the time, as this clock is used in AEM as digital clock and for the SMPS. Bluetooth uses 26 MHz analog clock.

**Figure 7: NHL-2NA Clocking.**




In SLEEP mode the VCTCXO is off. UEM generates low frequency clock signal (32.768 kHz) that is fed to UPP_WD2, Bluetooth and AEM.

### UPP_WD2 voltage/clock frequency adjusting

The systems of the BB make it possible to adjust both clock frequency and the core voltage of the main ASIC. Here is a rough description of the Clocking Scheme.

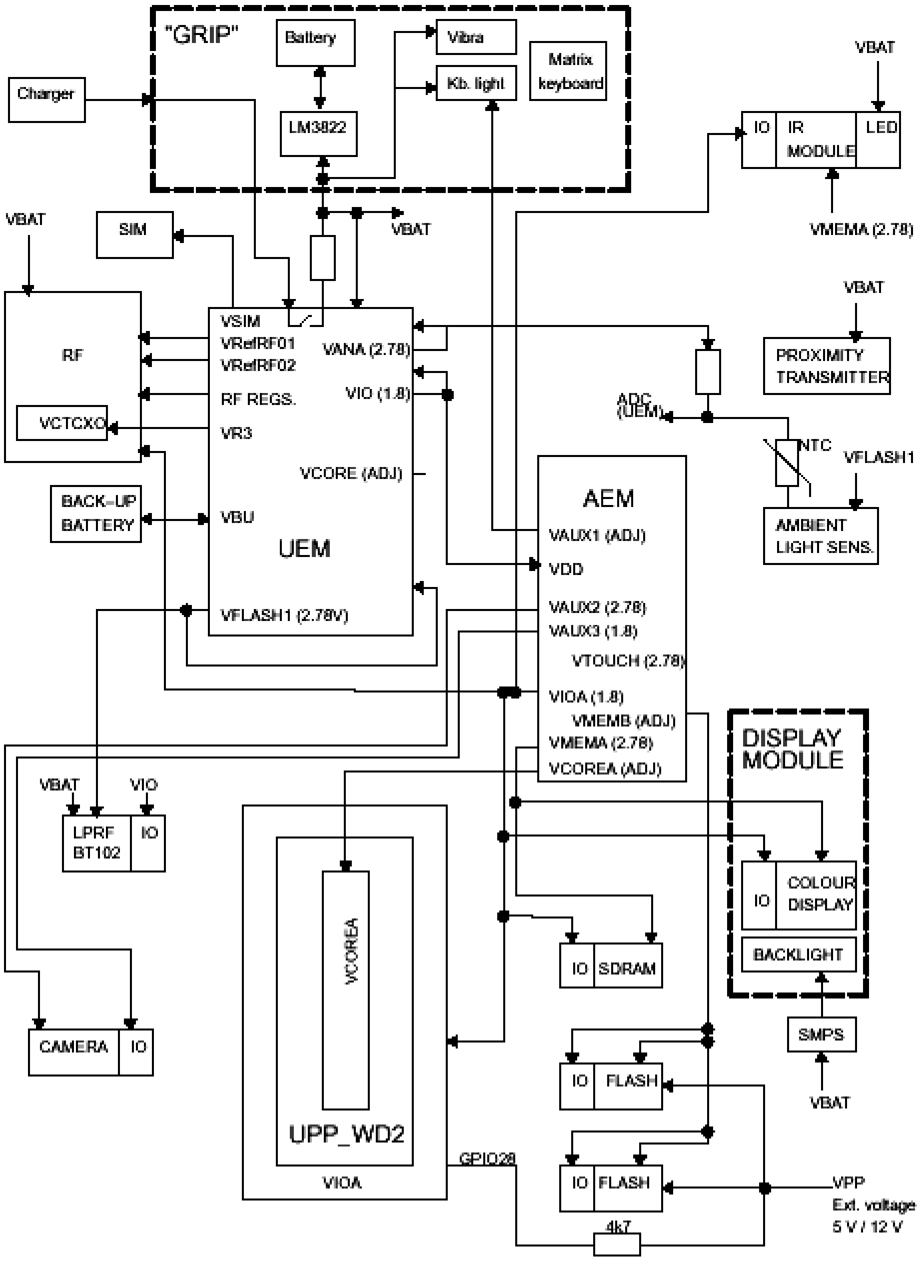
No external clock is available for UPP_WD2 before VCTCXO starts. As reset is released, the VCTCXO is running and MCU uses the 13 MHz clock while DSP is in reset. There are three identical DPLL's, for MCU, for DSP and for accessory interfaces, which can be controlled independently. The clock for MCU can be up to 104 MHz and 117 MHz is maximum clock Frequency for the DSP. These clock signals are used either directly (SDRAM IF) or divided down for the interfaces (e.g. flash IF).

## Power Distribution, Control and Reset

All power (except backup battery power) is drawn from BLB-2 Li-Ion battery located in the Grip part of the phone. Power goes through LM3822 current gauge which is used for current measurement and thus for remaining operating time estimation.

LG4 board contains two power ASIC's UEM and AEM which contain the regulators needed for generating the different operating voltages. In addition there is a SMPS in LG4 generating the operating voltage for display module backlighting. In LS4 keyboard the backlight is powered with a current pump.

**Figure 8: Power distribution diagram**



**Power-up sequence (Reset mode)**

RESET mode can be entered in four ways: by inserting the battery or charger, by RTC alarm or by pressing the power key. After voltage appearing at UEM's pin UEMRSTX (connected to AEM's pin REFENA) is used as indication for AEM to start up HW regulators. Also VCTXO is Powered up by using VR3 (UEM). After the 220 ms delays regulator are configured and UEM enters PWR_ON mode and system reset PURX is released.

During system start-up, in RESET state, the regulators are enabled, and each regulator charges the capacitor(s) at the output with the maximum current (short circuit current) it can deliver. This results in battery voltage dropping during the start-up. When a battery with voltage level just above the hardware cutoff limit is inserted, the system may not start due to excessive voltage dipping. Dropping below 2.8 V for longer than 5 us forces the system to PWR_OFF state.

**Powering off**

Controlled powering off is done when the user requests it by pressing power-key or when the battery voltage is falling too low. Uncontrolled powering off happens when battery is suddenly removed or if over-temperature condition is detected in regulator block while in RESET mode. Then all UEM's regulators are disabled immediately and AEM's regulators are disabled as VDD supply disappears.

**Controlled powering off**

For NHL-2NA powering off is initiated by pressing the power key and Power off sequence is activated in UEM and SW. Basically Power key cause UEM Interrupt to UPP_WD2 and SW sets Watchdog time value to zero and as this happens, PURX is forced low and all regulators are disabled.

If the battery voltage falls below the very last SW-cutoff level, SW will power off the system by letting the UEM's watchdog elapse.

If thermal shutdown limit in UEM regulator block is exceeded, the system is powered off. System reset PURX is forced low. AEM has its own thermal limit for regulators. Whenever the limit is exceeded, an interrupt is given to UPP_WD2 and SW should immediately power off the whole system. AEM will disable its regulators in any case by itself after 10 ms delay (uncontrolled powering off).

**Uncontrolled powering off**

This happens when the battery is suddenly removed and is problematic as data may corrupt in memories. UEM's state machine notices battery removal after battery voltage has been below $V_{COFF-}$ for 5 us and enters PWR_OFF mode. PURX is set low and all UEM's regulators are disabled. AEM's regulators except for VCOREA, VIOA, VMEMA and VMEMB are disabled as PURX goes low. These regulators stay enabled as long as there is voltage present at pin VDD (from UEM's VIO).

**Watchdogs**

There are three watchdogs in UEM. First one is for controlling system power-on and power-down sequences. The initial time for this watchdog after reset is 32 s and the watchdog can not be disabled. The time can be set using a register. This watchdog is used for powering the system off in a controlled manner. The other one is for security block and is used during IMEI code setting. The third one is a power key watchdog. It is used to power off the system in case SW is stuck and the user presses the power key. This WD is SW configurable.

There is also a "soft watchdog" in UPP_WD2. It is used to reset the chip in case software gets stuck for any reason. The Bluetooth module also contains a watchdog.

**Charging**

Charging controls and charge switch is in UEM. There are three different charging modes; charging empty battery (start-up charge mode), PWM charging mode (without SW control) and SW controlled charging.

UEM digital part takes care of charger detection (generates interrupt to UPP_WD2), pulse width modulated charging control (for internal charge switch and external performance charger) and over voltage and current detection. SW using registers controls all these.

**Chargers**

NHL-2NA BB is supporting a standard charger (two wires) or fast (performance) charger (three wires), Chargers ACP-7, ACP-8 and ACP-9 and ACP-12, Cigarette Charger LCH-8 are supported.

With the standard version the PWM signal is set to 1 Hz, while with fast charger it is set to 32 Hz. Also PWM signal is connected from UEM pin to the charger's control input.

Due to high current consumption of the NHL-2NA BB, a performance charger ACP-8 is needed.

**Battery**

NHL-2NA Battery is a detachable, semi-fixed Lithium-Ion BLB-2 battery. Other batteries are allowed to use but NOT charged. Nominal voltage is thus 3.6-3.7 V (max charging voltage 4.1-4.2 V).

The interface consists of four pins: VBAT, GND, BSI and BTEMP. Pull-down resistor inside of the batteries (BSI signal) recognizes the battery types. Voltage level at BSI line is measured with using Em's AD-converter.

## Back-up battery and real time clock

Real time clock (RTC), crystal oscillator and back-up battery circuitry reside in UEM. A register in UEM controls back-up battery charging and charging is possible only in POWER_ON State.

## Baseband Measurement A/D Converter

The UEM contains 11 channels A/D converter, which is used for different Baseband measurement purposes. The resolution of A/D converter is 10 bits. Converter uses the CBUS interface clock signal for the conversion. An interrupt will be given to the MCU at the end of the all measurement. Converter is used for following purposes.

- Battery Voltage Measurement A/D Channel (Internal)
- Charger Voltage Measurement A/D Channel (Internal)
- Charger Current Measurement A/D Channel (Internal)
- Battery Temperature Measurement A/D Channel (External)
- Battery Size Measurement A/D Channel (External)
- Light Sensor Measurement A/D Channel (External)
- PA Temperature measurement A/D Channel (External)
- VCTCXO Temperature measurement A/D Channel (External)

There is also auxiliary AD converter in UEM, which is used to monitor RF functions. Converter is controlled directly by UPP DSP. Converter can be used for following purposes:

VCXO Temperature measurement A/D Channel (if not used in normal AD)

PA Temperature measurement A/D Channel (if not used in normal AD)

# NHL-2NA BB Features & HW interfaces

## NHL-2NA BB User interface

### UI-Module Interface

Interface is for Color Display 176 x 208 (X3) resolution and backlight is white LED with lightguide. Also Part of Keyboard is locating in module with Navigation Key. Display is connected to LG4 by 30-pin Board-to-Board connector. Interface includes also power rails for UI and Backlight. Interface uses GPIO pins of UPP_WD2.

### Power Key

PWROnx of UEM is pulled up to battery voltage by a current source inside UEM. Pressing PWR-Key connects UEM PWRONX-pin to ground via resistor. The power key has also a reset function: while removing battery is difficult, a reset can be accomplished by pressing this key for longer time. Power key is connected to main PCB via spring contacts.

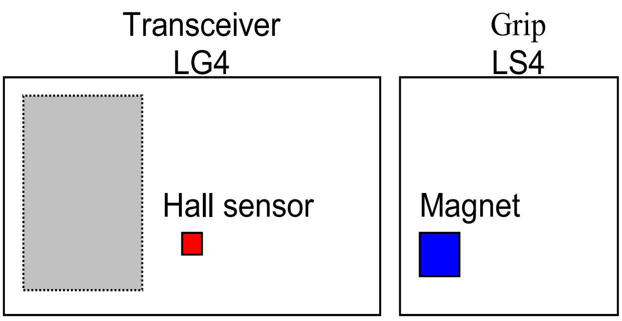
### Grip Interface

Grip Interface includes Matrix Keyboard & Backlight, Battery interface, Vibra Interface, Charger interface, Current Gauge interface.

Hall Sensor and Magnet

NHL-2NA is using Hall sensor TLE 4917 (NMP code 4341087) and magnet to find out the open/close position of the grip. The hall sensor component is in the LG4 BB area and the magnet is in the grip module. See Locations of the sensor and magnet below.

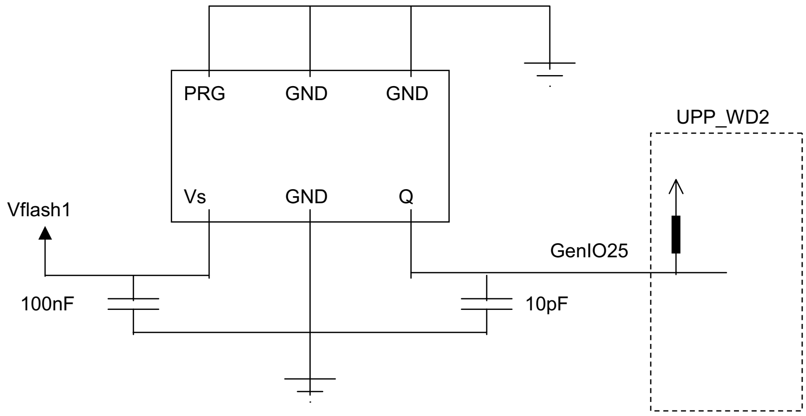
**Figure 9: Locations of the sensor and magnet**




As the grip is closed, the hall sensor and magnet are against each other. At this position the output of the hall sensor is high. As the grip is open and sensor and magnet are separated, the output is low. This low level gives the information to processor that grip is open.

Sensor needs 2.7V for operation and that's why Vflash1 voltage is needed to be connected to Vs pin. PRG pin is needed to connected GND that output is zero as magnet and sensor are separated. See Principle of the connection of the hall sensor below.

**Figure 10: Principle of the connection of the hall sensor**




Pins list of Hall sensors:

| Pin | Min | Nom | Max | Pin number |
|---|---|---|---|---|
| Vs | 2.4 V | 2.7 V | 3.5 V | 1 |
| GND | 0 V | | | 2, 4, 5 |
| Q | 0 V | 1.8 V | | 3 |
| PRG | 0 V | | 3.7 V | 6 |

## Bluetooth

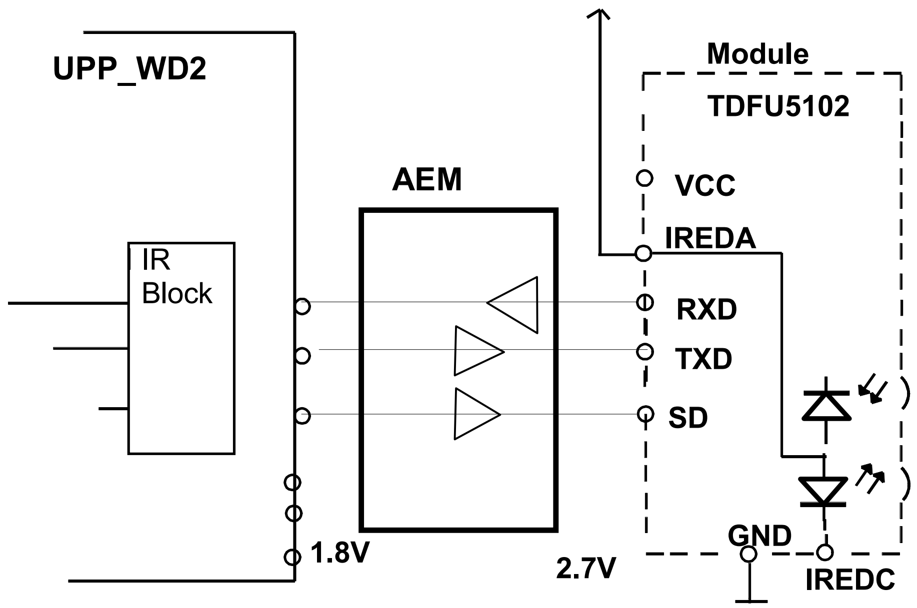
Bluetooth provides a fully digital link for communication between a master unit and one or more slave units. The system provides a radio link that offers a high degree of flexibility to support various applications and product scenarios. Data and control interface for a low power RF module is provided. The transmission is half-duplex. Air bit rate is 812.5 kbit/s.

## IR

NHL-2NA BB uses TDFU5102 1Mbit IrDA 1.1 **compatible module. Module interface signals are Tx (Transmitted Data), Rx (Received Data) and SD (ShutDown). IR transmission data speed can be from 9.6 kbit/s to 1.15 Mbit/s. The communication over the IR is always started using bit rate 9.6 kbit/s.**

Digital part is powered with 2.78 V by VMEMA and the LED by VBAT (nom. 4.2 V). VMEMA is fully SW-controlled regulator. More details of the module can be found out from IR specification under EDMS. See figure 11 for

**Figure 11: IR connected to UPP_WD2**




## SIM Interface

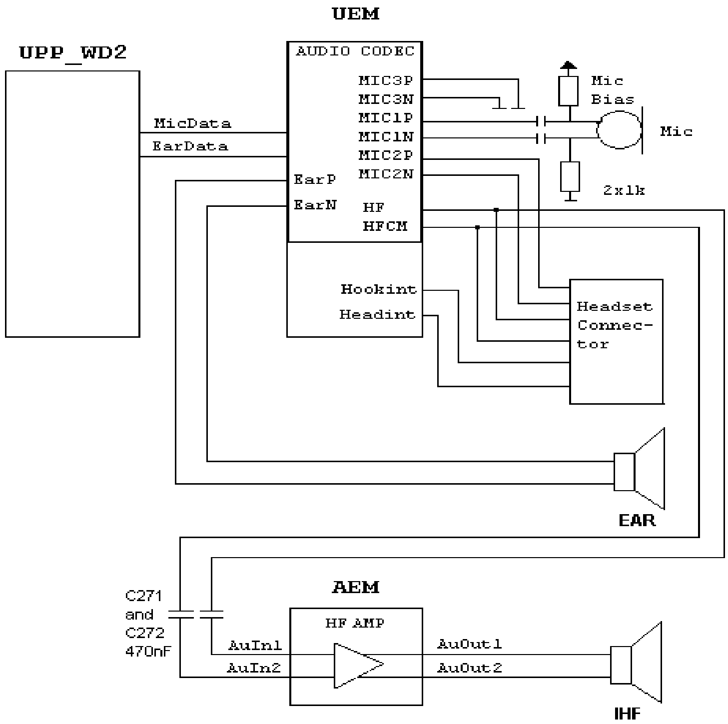
The SIM interface is located in two chips (UPP_WD2 and UEM). In UEM there is only support for one SIM card. The interfaces support both 1.8 V and 3 V SIM cards. Adjustable SIM regulator (1.8V/3.0V) is located in UEM and can be controlled by SW.

The data communication between the card and the phone is asynchronous half duplex. The clock supplied to the card is in GSM system 1.083 MHz or 3.25 MHz. The data baudrate is SIM card clock frequency divided by 372 (by default), 64, 32 or 16.

## NHL-2NA Audio Concept

NHL-2NA Audio's includes Earpiece, microphone, and headset connector, Integrated Handsfree (IHF) with proximity sensing. IHF have high quality Audio with DCT4 Enchantments. Headset is DCT4 monoheadset with/-out button. For IHF versus Earpiece function there is proximity sensor option, which detects if close to head, it switches IHF off. It can be turned ON Manually. In NHL-2NA Audio Blocks there is NHL-2NA BB Audio block diagram. Audio's are based on ASIC's UPP_WD2 and UEM.

**Figure 12: NHL-2NA Audio Blocks**




This Asic's readily support normal audio functionality. Between UPP_WD2 and UEM the audio signals are transferred in digital format using signals MICDATA and EARDATA. The microphone is connected to UEM and the headset output of UEM is fed also to AEM audio amplifier. So actual IHF situation the signal is also existing in Headset signals. NHL-2NA audio SW controls IHF amplifier power off when uses headset because both use same audio lines (HF and HFCM). Ringing tones and warning/info tones are to be produced with the IHF speaker also.

### Earpiece

The earpiece to be used in NHL-2NA is an 8-mm Pico earpiece. It has 32Ω continuous impedance and continuos power 8 mWatts. It Contacts to PWB Special adapter via springs. It's driven by differential signals from UEM (EARP & EARN)

### Microphone

The microphone capsule for NHL-2NA is a WM64MN capsule. Its sensitivity is -41db Nominal and it's provided encapsulated in housing of neoprene. Contacts are done by springs.

Two inputs are used from UEM, one for normal internal microphone and a second for headset. The third microphone input is not used, so it must connected to ground. Microphone bias block in UEM generates bias voltages for handportable and HandsFree/headset microphones. For both microphone bias outputs (MICB1 & MICB2) the minimum output voltage is 2.0 Volts and maximum output current is 600 µA. Microphone bias block also includes a low pass filter for the reference voltage used as an input for the MICB1&2 amplifiers.

### IHF Amplifier and Speaker

The speaker to be used in NHL-2NA is a 16mm 8Ω speaker. It can handle 0.2 Watts nominal Power and Peak power 0.4 Watts. Component has molded neoprene gasket and its contact to PWB via springs.

HF and HFCM lines of UEM are use to drive AEM IHF amplifier. IHF amplifier consists of four blocks: gain setting stage, power amplifier, and comparator and Bias VCM generation. There is also some digital logic, which is integrated to other digital parts of AEM.

Power amplifier is a differential opamp. The differential output is intended to HandsFree speaker. HandsFree amplifier load impedance is 8 ohm.

The outputs go into a high impedance state when powered down. The amplifier can be enabled and shut down by control register.

SW realizes IHF and earpiece volume control mainly in AEM. For maximum signal–to–noise performance it is preferable to set the gain of UEM's earpiece driver to some fixed, close–to–maximum value and use lower gain setting for AEM audio amplifier. Gain setting can be done in 2 dB steps, from –40 to +6 dB. Output sound pressure level of the internal HandsFree speaker is controlled by the proximity sensor and SW (CBus is used for controlling). Proximity sensor activity changes the gain automatically.

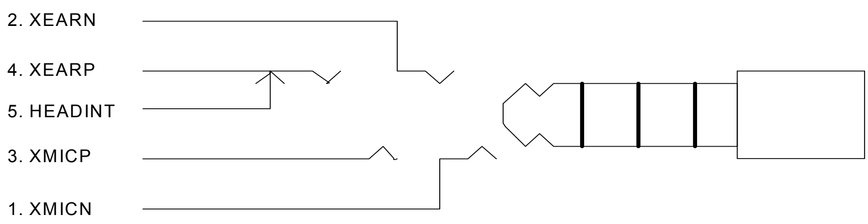
The schematic around the AEM IHF amplifier is presented in NHL-2NA schematics. The schematic shows all the filtering needed and also protection components against ESD and EMC.EMC and ESD Filtering component must be as near as possible to earphone pads of the phone. Audio input lines components DC decoupling capacitors and EMC capacitor must be located near to AEM.

The supply voltage for the IHF amplifier is filtered directly from the battery voltage. The size of the capacitance needed for smoothing the voltage is High-Pass filter consist of two parallel 220uF capacitors to ground with 2x2.2Ohm parallel in Series in VBAT line.

### External Audio interface

In NHL-2NA there is Headset Connector which is fully differential 4–wire connection.

**Figure 13: External Audio Connector**




The Handsfree (HF) driver in UEM is meant for headset. In NHL-2NA case the output is driven in fully differential mode. In the fully differential mode HF pin is the negative output and HFCM pin is the positive output. The gain of the Handsfree driver in the differential mode is 6 dB. The earpiece (EARP, EARN) and headset (HF, HFCM) signals are multiplexed so that the outputs can not be used simultaneously. Minimum resistive and maximum capacitive loading between HF and HFCM outputs are 30ohm and 10nF. The HF and HFCM amplifiers include a transient suppression circuitry, which prevents unwanted spikes in HF and HFCM outputs when switching on and off the amplifiers.

The plug opens a mechanical switch inside the connector between HF and HeadInt lines. The HeadInt line will be pulled up to 2.7V by internal resistor when the switch is open. When not having the plug inserted the voltage in the HeadInt line will be <0.8 V caused by internal pull down resistor in the HF line.

## Camera Interface

NHL-2NA camera type is a Still camera with viewer option. Camera resolution is VGA. The Camera module is connected by springs to PWB.

Camera interface is serial CCP, which is unidirectional interface; the control information to camera is transmitted through I2C bus. The I2C is implemented purely by SW using general purpose I/Os.

CCP interface consists of differential type of clock signal and one data signal. CCP enables the use of high data rates with low EMI; maximum transfer capacity is 104 Mbit/s, which means that transferring VGA (640x480) images at 15 fps is possible. CCP has three image data operating modes: 8-bit, 10-bit and 12-bit ones.

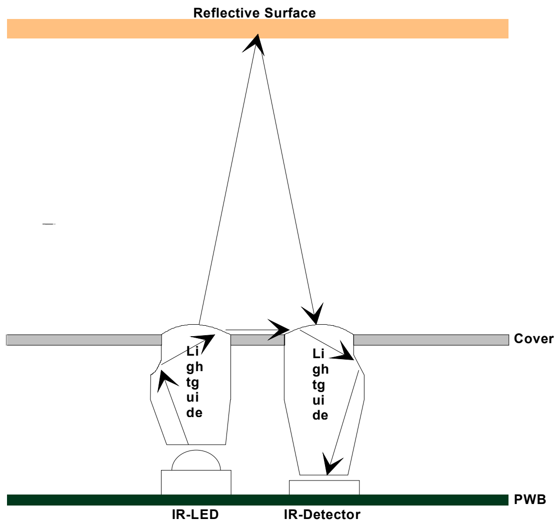
AEM includes two dedicated regulators for powering internal camera, 2.78V for logic and sensor and 1.8V for I/O.

More about camera module later in this section.

## Proximity Sensor

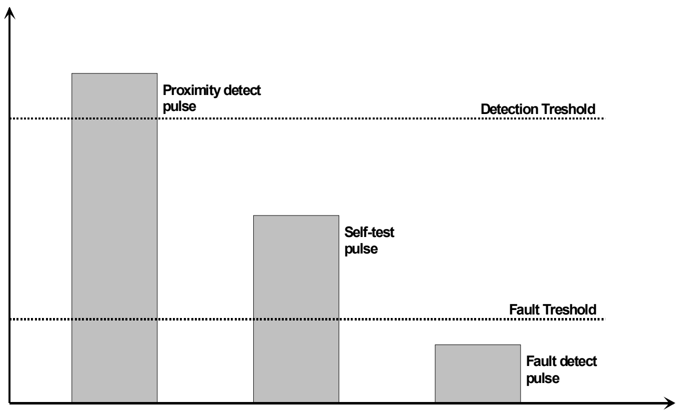
Proximity Detector is used to deactivate IHF when something is close to the phone. Proximity detection is based on detecting level of reflected IR radiation. Detection distance varies depending on the reflecting surface. System is calibrated to detect 20% diffuse reflectance targets, parallel to the phone, at 50mm distance. Detection distance may change due to wearing; minimum detection distance allowed is 30mm.

**Figure 14: Proximity Detector Principle**




Proximity Detector has also a self-monitoring feature, which is used to detect possible failures in the Proximity Detector. Proximity Detector Principle figure describes the mechanical concept of the Proximity Detector, Pulse levels shows signal levels.

**Figure 15: Pulse levels**




Proximity detector interface is in AEM (Auxiliary Energy Management ASIC), other components of the proximity detector are optoelectrical components and optics.

The proximity detector block on AEM consists of digital and analog part. Digital logic is included in digital part of AEM, and it is controlled through proximity detector control register.

Analog part includes a current source for the emitter and a transinpedance amplifier, high pass filter to filter off up to 2mA DC-current, gain-controllable amplifier and two comparators with adjustable thresholds in the receiver.

Proximity detector block enables several pulse width and pulse frequency selections and emitter current can be controlled with a current sensing resistor. In NHL-2NA emitter current is 100mA, pulse width 8µs and pulse frequency 500/2000Hz.

## Proximity Detector components

### Lightguides

Lightguides are needed to guide emitted IR radiation outside the phone as well as to guide the reflected pulses into the phone to the photodiode. Half angle of the emitted radiation is 10°. This means, that most of the emitted radiation is reflected from a circle that has diameter 20mm, when the target is at 50mm distance. Receiver lightguide collects radiation and guides it to the photodiode. Optical insulator, made of black rubber, surrounds the photodiode so that it cannot receive any radiation that is reflected inside the phone.

Self-monitoring signal is created with small reflector areas and curved top surfaces in the lightguides. Reflectors are placed inside the phone, so that they are subject to as little wearing as possible.

### IRED

The IRED type is CL-200-IR-X-TU (NMP CODE 4860009), which has high radiant intensity and relatively small half angle (28°). Maximum forward current is 100mA (pulsed 1A) and $V_f$ =1.3V. Rise Time is 2µs, total radiant intensity 12mW (at 50mA current) and peak radiant intensity at 950nm.

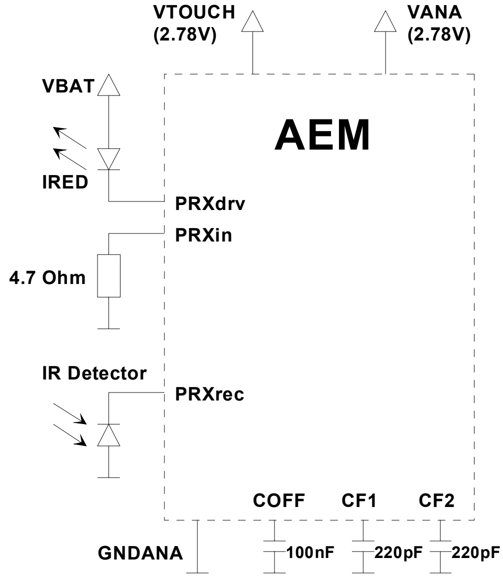
### Photodiode

The photodiode is BPW34FS (NMP CODE 486J830). It has peak sensitivity at 950nm and filtering for visible light. Photodiode receives radiation from 60° half angle and its rise time is 20ns.

### HW Implementation

The implementation of the proximity sensor is described in figure 16. Note that VTOUCH is connected externally to VANA.

Figure 16: Proximity sensor implementation

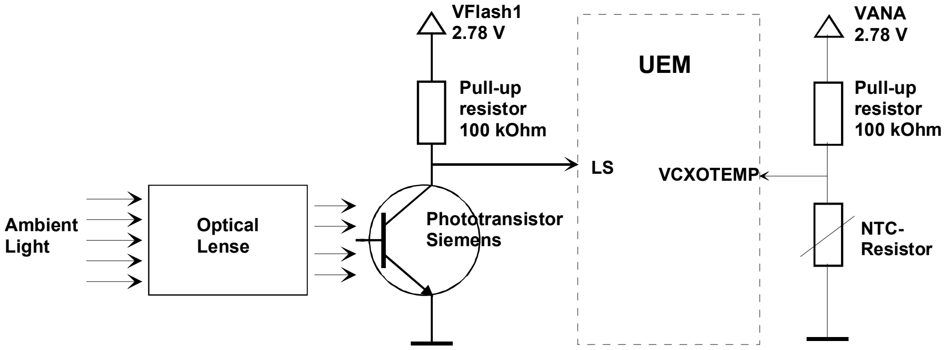


## Ambient Light Sensor

Ambient Light Detector (ALD) is used as a power saving feature.

Ambient Light Detector (ALD) measures illuminance on the display (ambient light). User can select the limit, above which display backlight is not needed. In practice, two limits are used in software to produce hysteresis. Hysteresis is needed to prevent backlight from blinking. Backlight can be switched ON only when ambient light level is below lower limit. Backlight is switched OFF, when ambient light level exceeds higher limit.

**Figure 17: Ambient light sensor implementation**



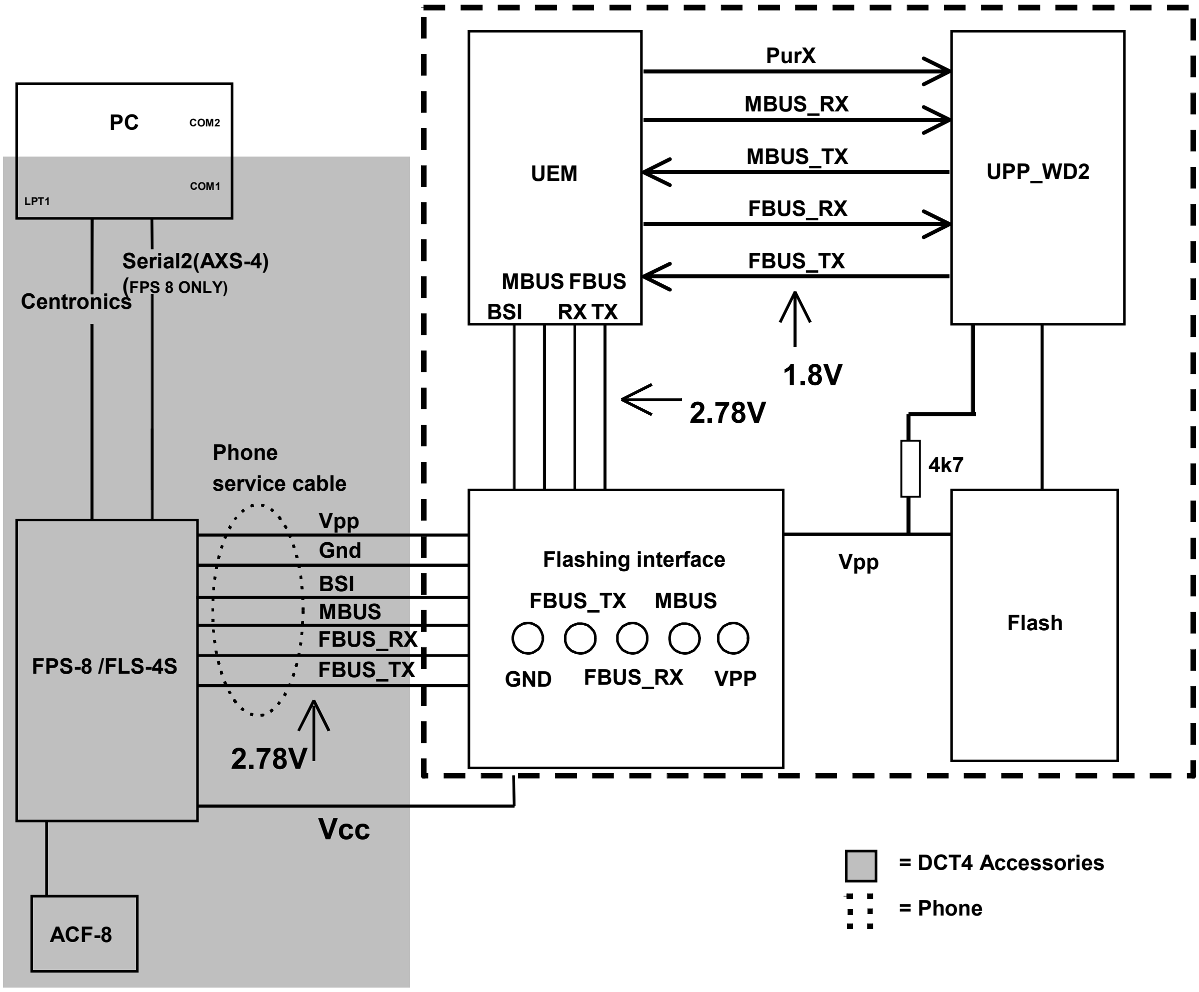
## Flashing

SW download in service is impelemented by custom tools and SW, kindly refer to Service Software Instructions and Service Tool section of the manual.

### Connections to Baseband

NHL-2NA type flash programmer FPS-8 is connected to the baseband directly in Production Tester, by using service cable and FLA-21 or Module jig to connect to test pads. With assembled devices the testpads can be accessed by opening the grip with a special tool.

**Figure 18: Flash programming connections**




FPS-8 can also supply Vcc during flash programming i.e. service box's or service battery's Vcc can be connected to FPS-8 by banana plugs but external power supply can be also used during flash programming. shows how flash programming equipment is connected. Note that Vcc connected to FPS-8/FLS-4S is preferred.

The flash programming interface uses following external signals:

1. FBUS RX (accessed from test pad pattern)
2. FBUS TX (accessed from test pad pattern)
3. MBUS (accessed from test pad pattern)

4 BSI (accessed from battery connector)
5 Vcc (accessed from battery connector)
6 Ground (accessed from test pad pattern and battery connector)
7 Vpp (accessed from test pad pattern)

In HDB15 BB Vpp routing is based on common DCT4 solution. In this solution the use of higher Vpp voltage is enabled at FLALI phase in production and in after sales if so wanted.

External voltage (Vpp) is used during flash programming in production and possibly in aftersales to speed up the process. In production, the usage of external programming voltage is a necessity but in after sales the usage of external programming voltage does not necessarily bring any noticeable improvement to flash programming time.

## Testing interfaces

In NHL-2NA BB Interfaces Because of Camera, larger memory, sensors there are some specific testing done and also because of flagship concept there is difference of physical Interfaces

**Table 1: Testing interface Electrical Specifications**

| Pin | Name | Dir | Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|---|---|---|
| 1 | MBUS | <-> | Vol | 0 | 0.2 | 0.3*VFlash1 | V | |
| | | | Vil (From Prommer) | 0 | 0.2 | 0.3*VFlash1 | V | |
| | | | Voh | 0.7*VFlash1 | 2.7 | 0.7*VFlash1 | V | |
| | | | Vih(From Prommer) | 0.7*VFlash1 | 2.7 | VFlash1 | V | |
| 2 | FBusTx | -> | Vol | 0 | 2.7 | 0.3*VFlash1 | V | |
| | | | Voh | 0.7*VFlash1 | 2.7 | VFlash1 | V | |
| 3 | FBusRx | <- | Vil (From Prommer) | 0 | 2.7 | 0.3*VFlash1 | V | |
| | | | Vih(FromPrommer) | 1.89 | 2.7 | VFlash1 | V | |
| | | | Abs. Max. Voltage to Test Pad Referenced to GND | -0.3V | | 3.0 | V | Absolute Max Voltage limits to MBUS/FBUS |
| 4 | VPP | | To Phone | 0 / 2.8 / 12 +/-3% | V | Prommer Select | 4 | VPP |
| 4 | VPP | | To Phone | 0 / 2.8 / 12 +/-3% | V | Prommer Select | 4 | VPP |
| 5 | GND | | | | 0 | | V | VBAT GROUND |

Note1: VFlash1 is 2.78 +/- 3%

**Table 2: Electrical Specifications for Power Supply Interface in Prod Testing**

| Pin | Name | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|---|
| 1 | VBAT | 0 | 3.6 | 5.1 | V | |
| 2 | BSI | 0 | 2.78 | VFlash1 | V | Internal pullup |
| 3 | BTEMP | 0 | 3.0 | VAna | V | Internal pullup |
| 4 | GND | 0 | | | V | |

*Note 1: VAna & VFlash1 = 2.78 +/-3%*

## Extreme Voltages

Lithium-Ion battery BLB-2 (1 cell):

- Nominal voltage is 3.6V
- Lower extreme voltage is 2.8V (cut off voltage)
- Higher extreme voltage is 4.2V (charging high limit voltage)

## Temperature Conditions

Specifications are met within range of –10C to +55C ambient temperature. Reduced operation between [-25] and [+60]. Storage temperature range is of –40C to +85C according to Nokia specifications.

## Humidity and Water Resistance

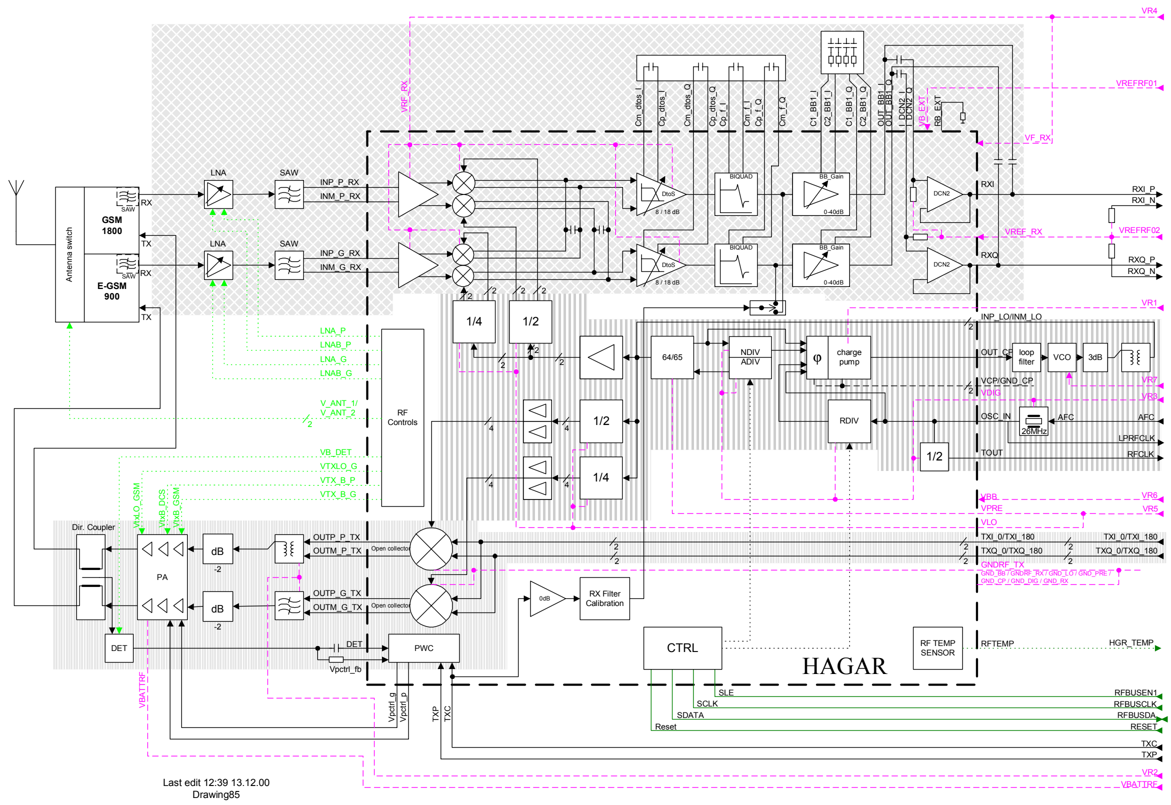
Relative humidity range is 5 ... 95%. Condensed or dripping water may cause intermittent malfunctions. Protection against dripping water have to be implemented in (enclosure) mechanics. Continuous dampness will cause permanent damage to the module.

# RF Module

## Functional block descriptions

The block diagrams of direct-conversion receiver and transmitter RF section are described in the following figure. The illustration shows the RF-IC ( both RX and TX functions ), power amplifier ( PA ), TX-SAW filter, VCO, VCTCXO module, discrete LNA stages and SAW-filters for receive bands.

**Figure 19: RF block description**



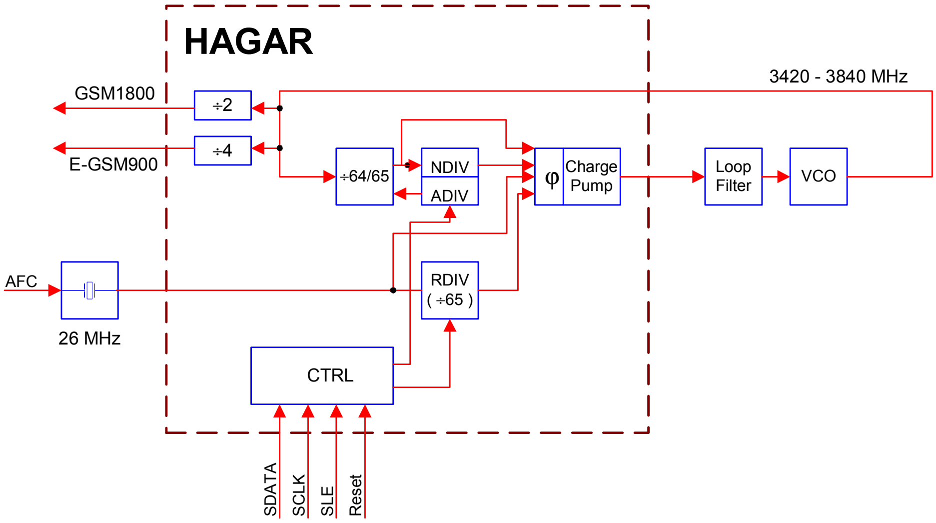

## The Frequency synthesizer

The VCO frequency is locked using a PLL to a stable frequency source, which is a VCTCXO. The VCTCXO is running at 26 MHz. The Temperature effect is controlled with AFC. The AFC is generated with a 11 bit conventional DAC in UEM.

The physical PLL is located inside the HAGAR RF-IC and is controlled via serial bus. The PLL synthesizer consists of the following blocks :

- 64/65 CML prescaler
- Programable R-, N- and A-dividers,
- Phase detector and charge pump

**Figure 20: Phase locked loop**




The SHF local signal generated by a VCO module is fed into prescaler. The prescaler is a dual-modulus divider. The output of the prescaler is fed to N- and A- divider which produce the input to phase detector. The phase detector compares this signal to the reference signal (400 kHz) which is obtained by dividing the VCTCXO output by reference R-divider. The output of the phase detector is connected to the charge pump which charges or discharges integrator capacitor in the loop filter, depending on the phase of the measured frequency compared to the reference frequency.

The loop filter, VCO and VCTCXO are all external synthesizer building blocks.

The loop filter performs filtering of the pulses and generates DC control voltage to the VCO. The loop filter also defines the step response of the PLL ( settling time ) and effects the stability of the loop. That's why integrator capacitor has got a resistor for phase compensation. The other filter components are for sideband rejection.

The dividers are controlled via serial bus: SDATA is for data, SCLK is serial clock for the bus and SLE is latch enable, which enables new data storage into dividers.

The transceiver LO signal is generated by VCO module. The VCO generates double frequency in GSM1800 and times four frequency in E-GSM900 compared to the actual RF channel frequency. LO signal is divided by two or four in HAGAR ( depending on system mode ).

This RF module comprises all RF functions of the engine. RF circuitry is located on one side (B-side) of the PCB.

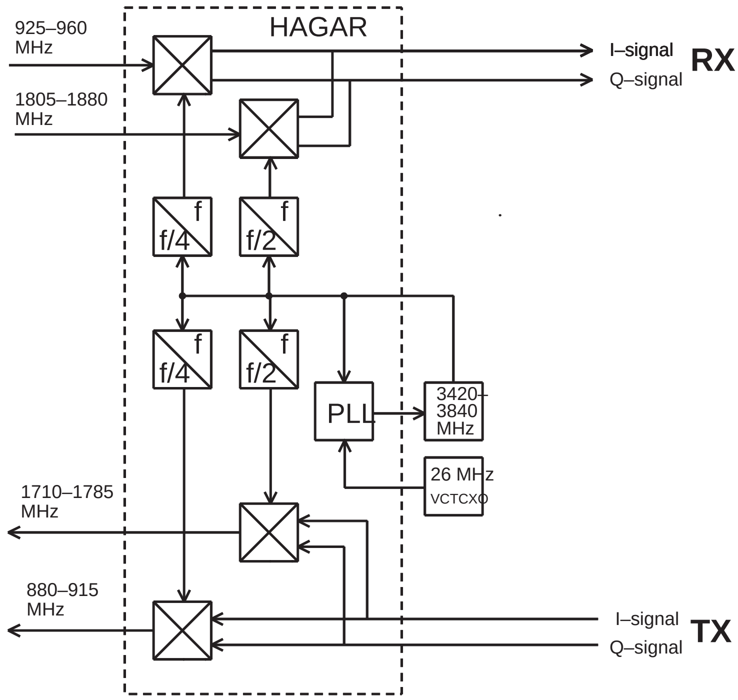
EMC leakage is prevented by using a metal B-shield, which screens the whole RF side (included FM radio) of the engine. The conductive (silicon or metal) gasket is used between the PCB and the shield. The metal B-shield is separated to three blocks. The first one include the FM radio. The second block include the PA, antenna switch, LNAs and dual RX SAW. The last block include the Hagar RF IC, VCO, VCTCXO, baluns and balanced filters.

The baseband circuitry is located on the A-side of the board, which is shielded with a metallized frame and ground plane of the UI-board.

Maximum height inside on B-side is 1.8 mm. Heat generated by the circuitry is conducted out via the PCB ground planes and metallic B-shield

## RF Frequency Plan

**Figure 21: RF Frequency plan**



### DC characteristics

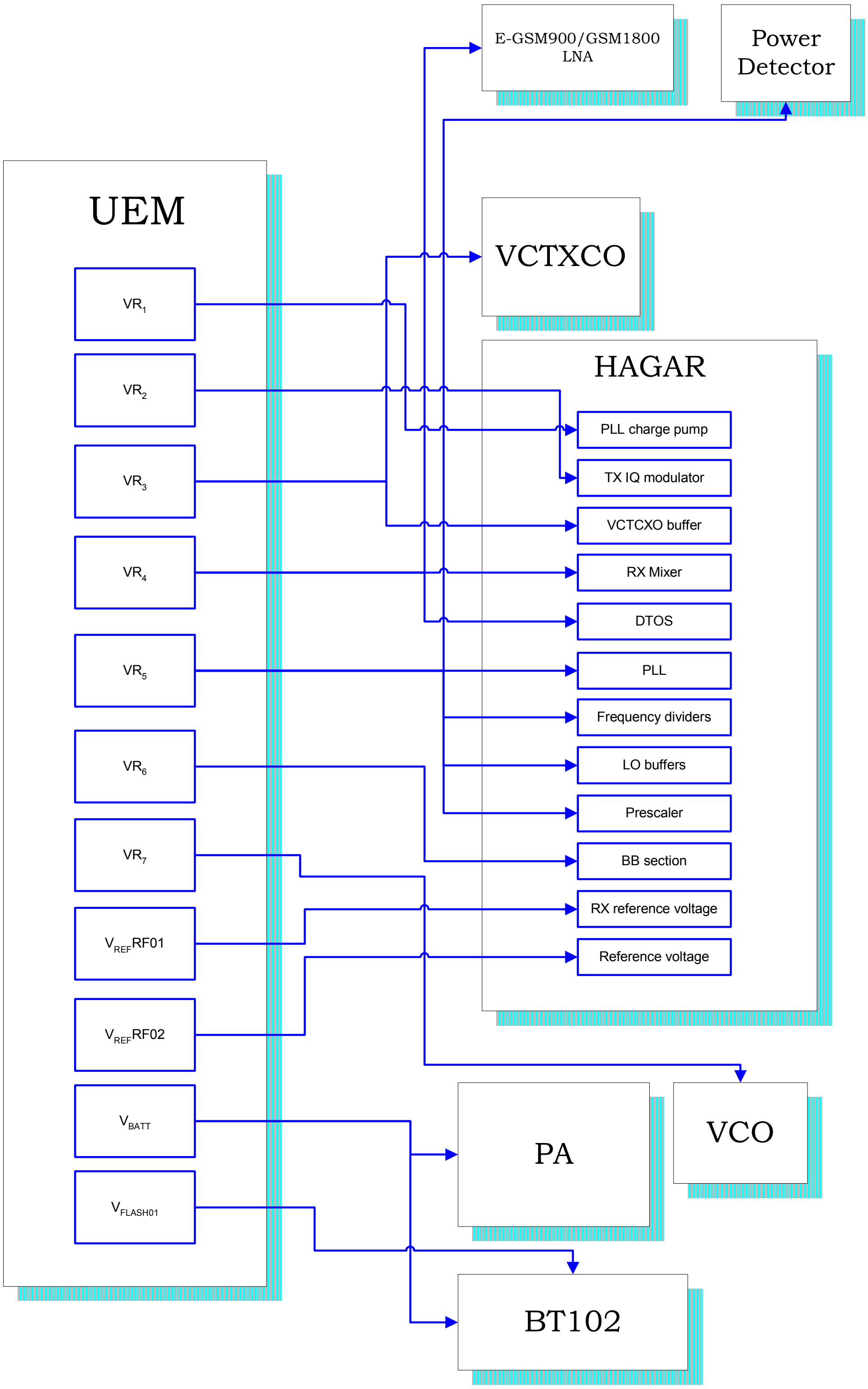
#### Regulators

List of the needed supply voltages :

| Volt. source | Load |
|---|---|
| VR1a | PLL charge pump (4,8 V) |
| VR2 | TX modulator |
| VR3 | VCTCXO + buffer |
| VR4 | HAGAR IC (LNAs+mixer+DTOS) |
| VR5 | HAGAR IC (div+LO-buff+prescaler), |
| VR6 | HAGAR (Vdd_bb) |
| VR7 | VCO |
| VrefRF01 | ref. voltage for HAGAR |
| VrefRF02 | ref. voltage for HAGAR |
| Vbatt | PA |

## Power Distribution Diagram

Figure 22: Power Distribution Diagram



## RF characteristics

| Item | Values (E-GSM / GSM1800) |
|---|---|
| Receive frequency range | 925 ... 960 MHz / 1805...1880 MHz |
| Transmit frequency range | 880 ... 915 MHz / 1710...1785 MHz |
| Duplex spacing | 45 MHz / 95 MHz |
| Channel spacing | 200 kHz |
| Number of RF channels | 174 / 374 |
| Power class | 4 (2 W) / 1 (1 W) |
| Number of power levels | 15 / 16 |

Transmitter characteristics

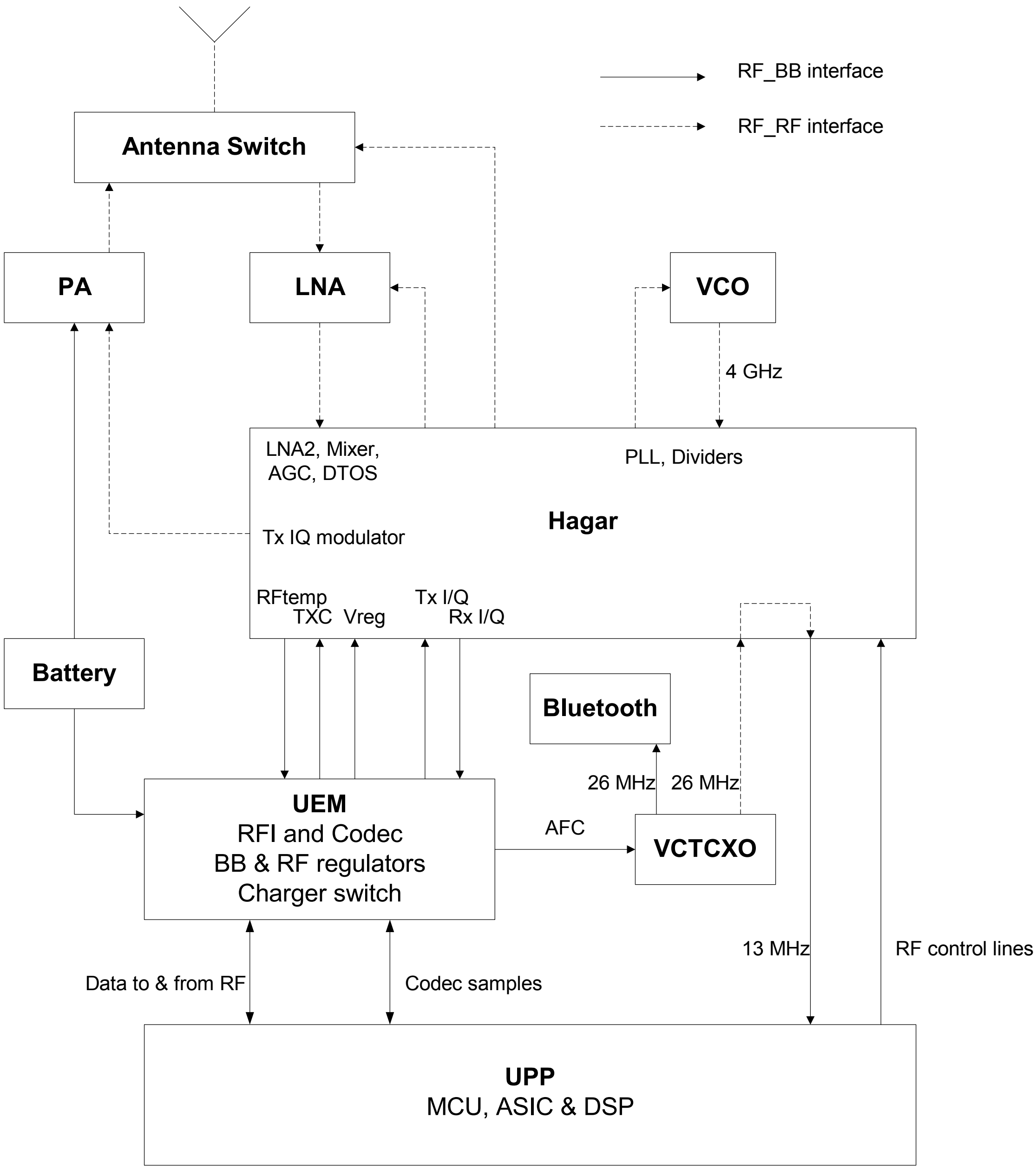
| Item | Values (E-GSM/GSM1800) |
|---|---|
| Type | Direct conversion, nonlinear, FDMA/TDMA |
| LO frequency range | 3520...3660 MHz / 3420...3570 MHz |
| Output power | 2 W / 1 W peak |
| Gain control range | min. 30 dB |
| Maximum phase error ( RMS/peak ) | max 5 deg./20 deg. peak |

Receiver characteristics

| Item | Values, E-GSM/GSM1800 |
|---|---|
| Type | Direct conversion, Linear, FDMA/TDMA |
| LO frequencies | 3700...3840 MHz / 3610...3760 MHz |
| Typical 3 dB bandwidth | +/- 91 kHz |
| Sensitivity | min. - 102 dBm (GSM1800 norm.cond. only) |
| 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 25 dB EGSM |
| Usable input dynamic range | -102 ... -10 dBm |
| RSSI dynamic range | -110 ... -48 dBm |
| Compensated gain variation in receiving band | +/- 1.0 dB |

## RF Block Diagram

Figure 23: RF Block Diagram




For further information see table on the next page.

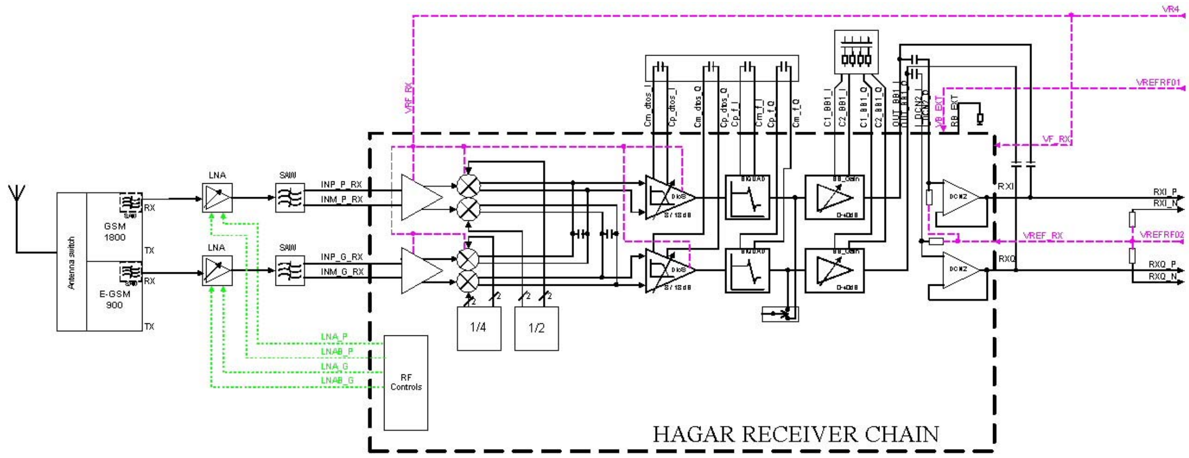
## Voltage Supplies and References

| Signal name | From | To | Parameter | Min | Typ | Max | Unit | Function |
|---|---|---|---|---|---|---|---|---|
| VBAT | Battery | PA & UEM | Voltage | 2.95 | 3.5 | 5.15 | V | Battery supply. Cut-off level of DCT4 regulators is 3.04V. Losses in PWB tracks and ferrites are taken account to minimum battery voltage level. |
| | | | Current | | | 2000 | mA | |
| | | | Current drawn by PA when "off" | | 0.8 | 2 | mA | |
| VR1 | UEM | VCP | Voltage | 4.6 | 4.75 | 4.9 | V | Supply for varactor for UHF VCO tuning. |
| | | | Current | | 2 | 10 | mA | |
| | | | | | | | | |
| | | | Noise density | | | 200 | nVrms/sqrt(Hz) | |
| VR2 | UEM | VRF_TX | Voltage | 2.70 | 2.78 | 2.86 | V | Supply for part of transmit strip. Supply for TX I/Q-modulators. |
| | | | Current | | 65 | 100 | mA | |
| | | | Noise density<br>f=100Hz<br>f>300Hz | | | <br>80<br>55 | nVrms/sqrt(Hz) | |
| VR3 | UEM | VCTCXO | Voltage | 2.70 | 2.78 | 2.86 | V | Supply for VCTCXO |
| | | | Current | | 1 | 20 | mA | |
| | | | Noise density | | | 200 | nVrms/sqrt(Hz) | |
| VR4 | UEM | VRF_RX | Voltage | 2.70 | 2.78 | 2.86 | V | Supply for Hagar RX; preamp., mixer, DTOS<br>Noise density should have -20dB/° slope after 10kHz corner frequency |
| | | | Current | | | 50 | mA | |
| | | | Noise density<br>f=100..10kHz<br>f=100kHz | | | <br>200<br>20 | nVrms/sqrt(Hz) | |
| VR5 | UEM | VDIG, VPRE, VLO | Voltage | 2.70 | 2.78 | 2.86 | V | Supply for Hagar PLL; dividers, LO-buffers, prescaler, |
| | | | Current | | | 50 | mA | |
| | | | Noise density BW=100Hz to 100kHZ | | | 200 | nVrms/sqrt(Hz) | |
| VR6 | UEM | VBB | Voltage | 2.70 | 2.78 | 2.86 | V | Supply for Hagar BB and LNA |
| | | | Current | | | 50 | mA | |
| | | | Noise density BW=100Hz to 100kHz | | | 200 | nVrms/sqrt(Hz) | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| VR7 | UEM | UHF VCO | Voltage | 2.70 | 2.78 | 2.86 | V | Supply for UHF VCO |
| | | | Current | | | 30 | mA | |
| | | | Noise density<br>100Hz<f<2kHz<br>2kHz<f<10kHz<br>10kHz<f<30kHz<br>30kHz<f<90kHz<br>90kHz<f<3MHz | | | 70<br>55<br>35<br>30<br>30 | nVrms/<br>sqrt(Hz) | |
| VrefRF<br>01 | UEM | VREF_RX | Voltage | 1.33<br>4 | 1.35 | 1.36<br>6 | V | Voltage Reference for RF-IC.<br>Note:Below 600Hz noise density is allowed to increase 20 dB/oct |
| | | | Current | | | 100 | mA | |
| | | | Temp Coef | -65 | | +65 | uV/C | |
| | | | Noise density<br>BW=600Hz to<br>100kHz Note | | | 55 | nVrms/<br>sqrt(Hz<br>) | |
| VrefRF<br>02 | UEM | VB_EXT | Voltage | 1.33<br>4 | 1.35 | 1.36<br>6 | V | Supply for RF-BB digital interface and some dig-ital parts of RF. |
| | | | Current | | | 100 | mA | |
| | | | Temp Coef | -65 | | +65 | uV/C | |
| | | | Noise density<br>BW=100Hz to<br>100kHz | | | 400 | nVrms/<br>sqrt(Hz<br>) | |

## Receiver

**Figure 24: NHL-2NA Receiver chain**




The receiver is a direct-conversion, dual-band linear receiver. RF signal energy gathered by the antenna is fed via the antenna switch module to the 1st RX bandpass SAW filters and MMIC LNAs. The RF antenna switch module provides for upper- and lower-band operation. The signal having been amplified by the LNA is then fed to 2nd RX bandpass SAW filters. Both of these 2nd RX bandpass SAW filters have UNBAL/BAL configuration to achieve the balanced feed for HAGAR. The discrete LNAs have three gain levels. The first one is maximum gain, the second one is about -30dB ( GSM1800 ) and –25dB ( E-GSM900 ) below maximum gain and the last one is off state. The LNA gain selection is controlled directly by HAGAR.

The performance of the RX bandpass SAW filters are mainly responsible for defining the receiver's blocking characteristics against spurious signals outside passband and the protection against spurious responses.

The differential RX signal is amplified and mixed directly down to BB frequency in HAGAR. The LO signal is generated with external VCO. This VCO signal is divided by 2 ( GSM1800 ) or by 4 ( E-GSM900 ). The PLL and dividers are internal to the HAGAR IC. From the mixer output to ADC input RX signal is divided into I- and Q-signals. Accurate phasing is generated in LO dividers. After the mixer DTOS amplifiers convert the differential signals to single ended.

The DTOS has two gain stages. The first one has constant gain of 12dB and 85kHz cut off frequency. The gain of second stage is controlled with control signal g10. If g10 is high (1) the gain is 6dB and if g10 is low (0) the gain of the stage is -4dB. The active channel filters in HAGAR provide selectivity for channels (-3dB @ ± 91 kHz typ.). The integrated baseband filter inside HAGAR is an active-RC-filter with two off-chip capacitors. Large RC-time constants are needed in the channel select filter of the direct-conversion receiver and are achieved with large off-chip capacitors because the impedance levels could not be increased due to the noise specifications.

The baseband filter consists of two stages, DTOS and BIQUAD. DTOS is differential to single-ended converter having 8dB or 18dB gain. BIQUAD is modified Sallen-Key Biquad. Integrated resistors and capacitors are tunable. These are controlled with a digital control word. The correct control words that compensate for the process variations of integrated resistors and capacitors and of tolerance of off chip capacitors are found with the calibration circuit.

The next stage in the receiver chain is AGC-amplifier, also integrated into HAGAR. AGC has digital gain control via serial mode bms. AGC-stage provides gain control range (40 dB, 10 dB steps) for the receiver and also the necessary DC compensation. Additional 10 dB AGC step is implemented in DTOS stages.

DC compensation is made during DCN1 and DCN2 operations ( controlled via serial bus ). DCN1 is carried out by charging the large external capacitors in AGC stages to a voltage which effect a zero dc-offset. DCN2 set the signal offset to constant value ( $V_{ref}$RF_02 1.35 V ). The $V_{ref}$RF_02 signal is used as a zero level to RX ADCs.

Single ended filtered I/Q-signal is then fed to ADCs in BB. Input level for ADC is 1.45 $V_{pp}$ max.

Rf-temp port is intended to be used for compensation of RX SAW filters thermal behavior. This phenomena will have impact to RSSI reporting accuracy. The current information is -35ppm/C for center frequency drift for all bands. This temperature information is a voltage over two diodes and diodes are fed with constant current.

## Transmitter

Transmitter chain consists of two final frequency IQ-modulators for upper and lower band, a dual power amplifier and a power control loop.

I- and Q-signals are generated by baseband. After post filtering (RC-network) they go into IQ-modulator in HAGAR. There are separate outputs one for EGSM and one for GSM1800.

In EGSM branch there is a SAW filter before PA to attenuate unwanted signals and wideband noise from the Hagar IC.

The final amplification is realized with dual band power amplifier. It has two different power chains: one for EGSM and one for GSM1800. PA is able to produce over 2 W (0 dBm input level) in EGSM band and over 1 W (0 dBm input level) in upperband band into 50 ohm output . Gain control range is over 45 dB to get desired power levels and power ramping up and down.

Power control circuitry consists of discrete power detector (common for lower and upperband) and error amplifier in HAGAR. There is a directional coupler connected between PA output and antenna switch. It is a dual band type and has input and outputs for both systems. Directional coupler takes a sample from the forward going power with certain ratio. This signal is rectified in a schottky-diode and it produces a DC-signal after filtering.

### AGC strategy

The AGC-amplifier is used to maintain the output level of the receiver in within a certain range. The AGC has to be set before each received burst with pre-monitoring or without pre-monitoring. In pre-monitoring, the receiver is switched on roughly 130µs before the burst begins, DSP measures received signal level and adjusts AGC-amplifiers via serial bus.

With this particular receiver architecture, there is 50 dB of accurate gain control in 10 dB steps and large LNA step ( approximately 25dB for E-GSM900 and 30 for GSM1800). **LNA AGC step size depends on channel to some extent.**

In practice, this results in 6 accurate AGC steps and 2/3 non-accurate steps available to the UPP depending on the band.

Because of the requirement from the GSM specifications that each MS should be able to measure and report it's RSSI accurately when receiving levels below –48dBm, and due to the fact that the LNA step is not accurate, the LNAs should always be in the ON state in this situation. For all signals in excess of –48dBm the MS will report a constant value.

| Step no. | AGC Step value | AGC Gain | Front-end LNA state | Front-end LNA gain | |
|---|---|---|---|---|---|
| | | | | E-GSM900 | GSM1800 |
| 1 | 0 | -4 | OFF | -7 | -11 |
| 2 | 1 | +6 | OFF | -7 | -11 |
| 3 | 2 | +16 | OFF | -7 | -11 |
| 4 | 3 | -4 | ON | +18 | +19 |
| 5 | 4 | +6 | ON | +18 | +19 |
| 6 | 5 | +16 | ON | +18 | +19 |
| 7 | 6 | +26 | ON | +18 | +19 |
| 8 | 7 | +36 | ON | +18 | +19 |
| 9 | 8 | +46 | ON | +18 | +19 |

**Figure 25: Gain control of E-GSM900**

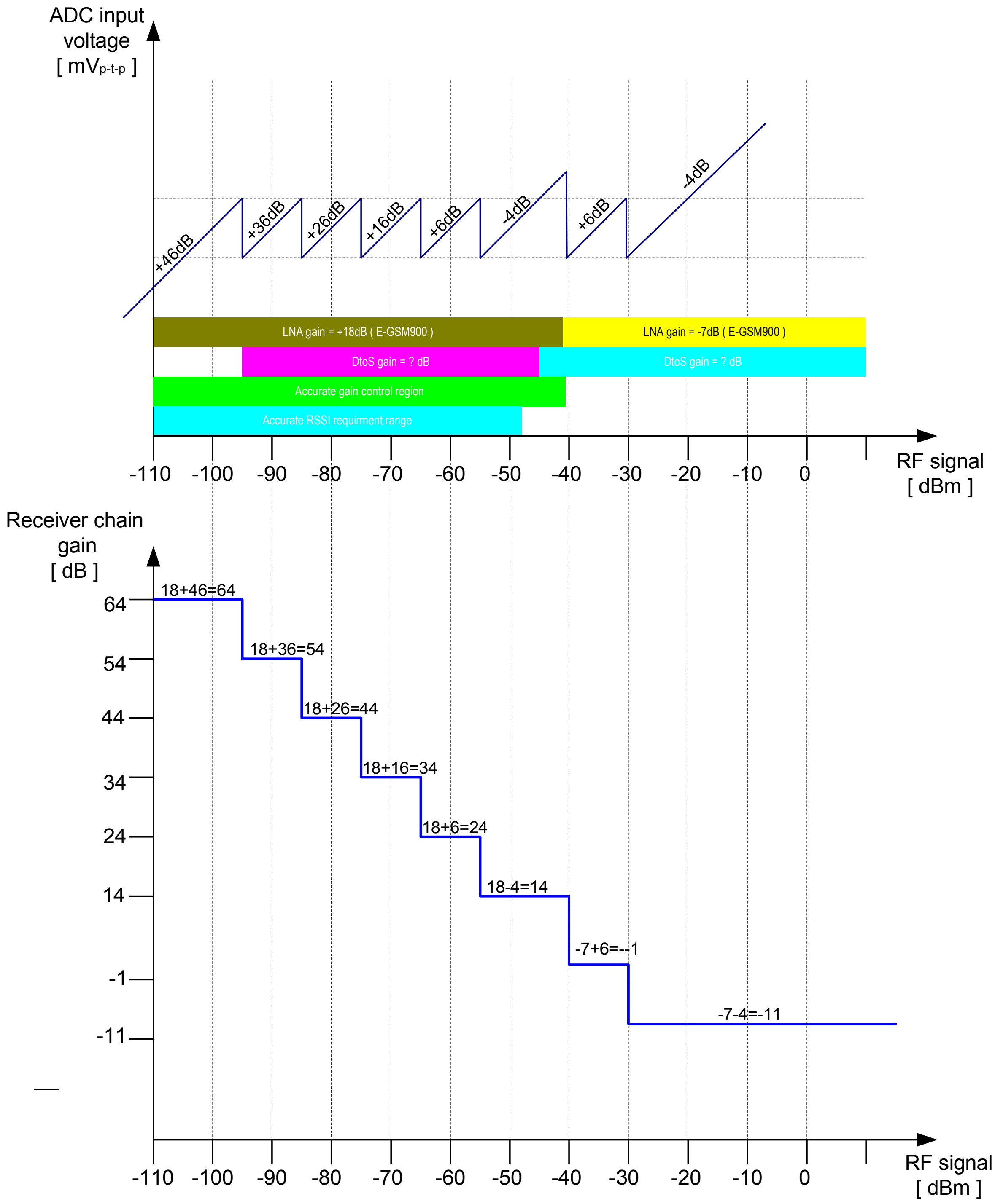
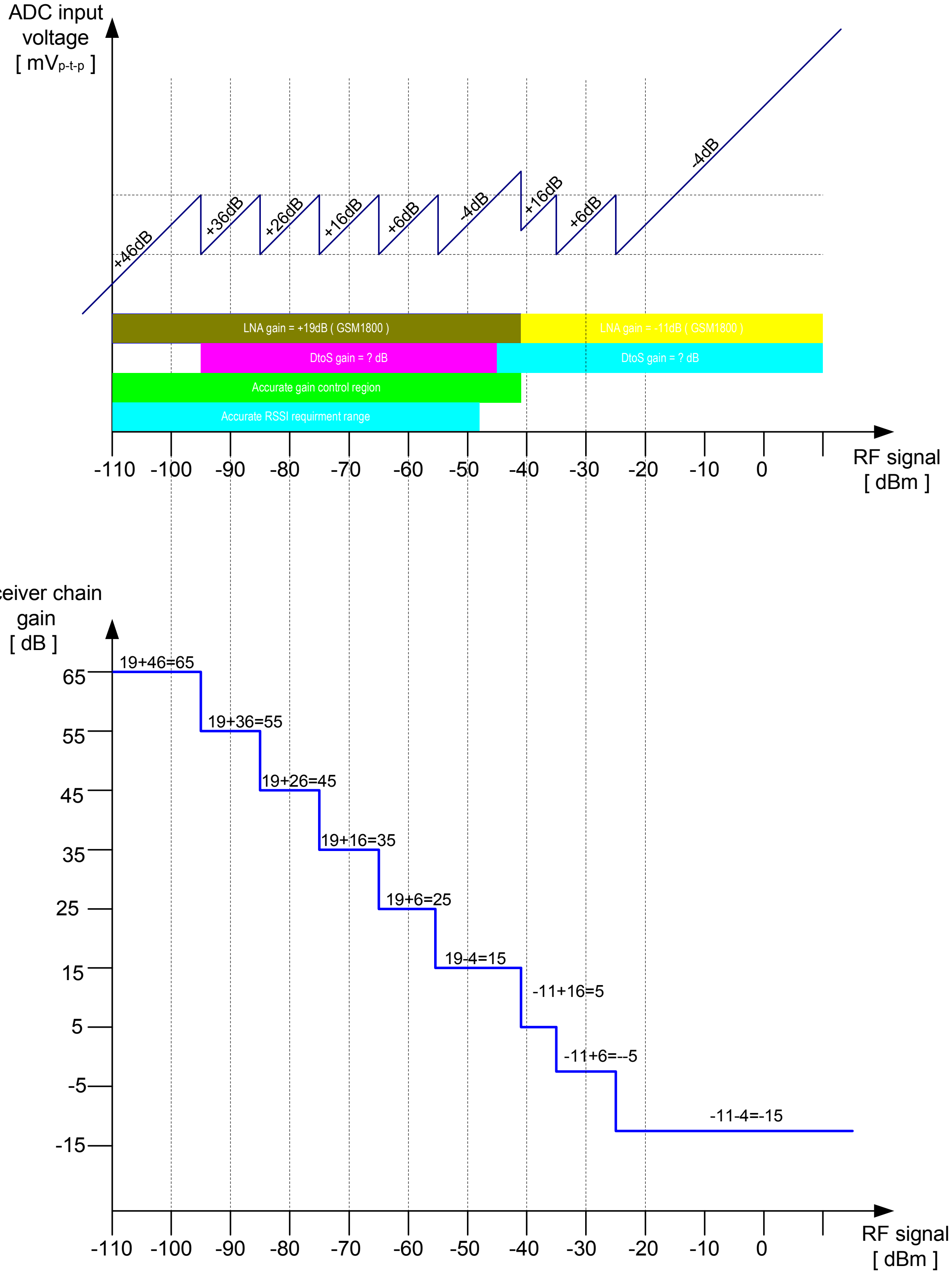


**Figure 26: Gain control of GSM1800**




## AFC function

The AFC is used to lock the transceivers clock to frequency of the base station. The AFC voltage is generated in baseband using an 11 bit DAC where an RC-filter is placed on the AFC control line to reduce the noise from the converter. The settling time requirement for the RC-network comes from signaling, i.e. how often PSW slots occur. They are repeated after 10 frames. The AFC tracks the base station frequency continuously which enables the transceiver to have a stable frequency reference.

The settling time requirement is also determined from the allowed start up-time. When the transceiver is in sleep mode and "wakes-up" to receive mode, there is only about 5 ms for the AFC voltage to settle. When the first burst is received, the system clock has to be settled into ± 0.1 PPM frequency accuracy. The VCTCXO module also requires 5 ms to settle into the final frequency. The amplitude rises into full swing in 1 to 2 ms, but the frequency settling time is higher so this oscillator must be powered up early enough.

**DC-compensation**

DC compensation is made during DCN1 and DCN2 operations (controlled via serial bus). DCN1 is carried out by charging the large external capacitors in AGC stages to a voltage which cause a zero dc-offset. DCN2 set the signal offset to constant value (RXREF 1.35 V). The RXREF signal is used as a zero level to RX ADCs.

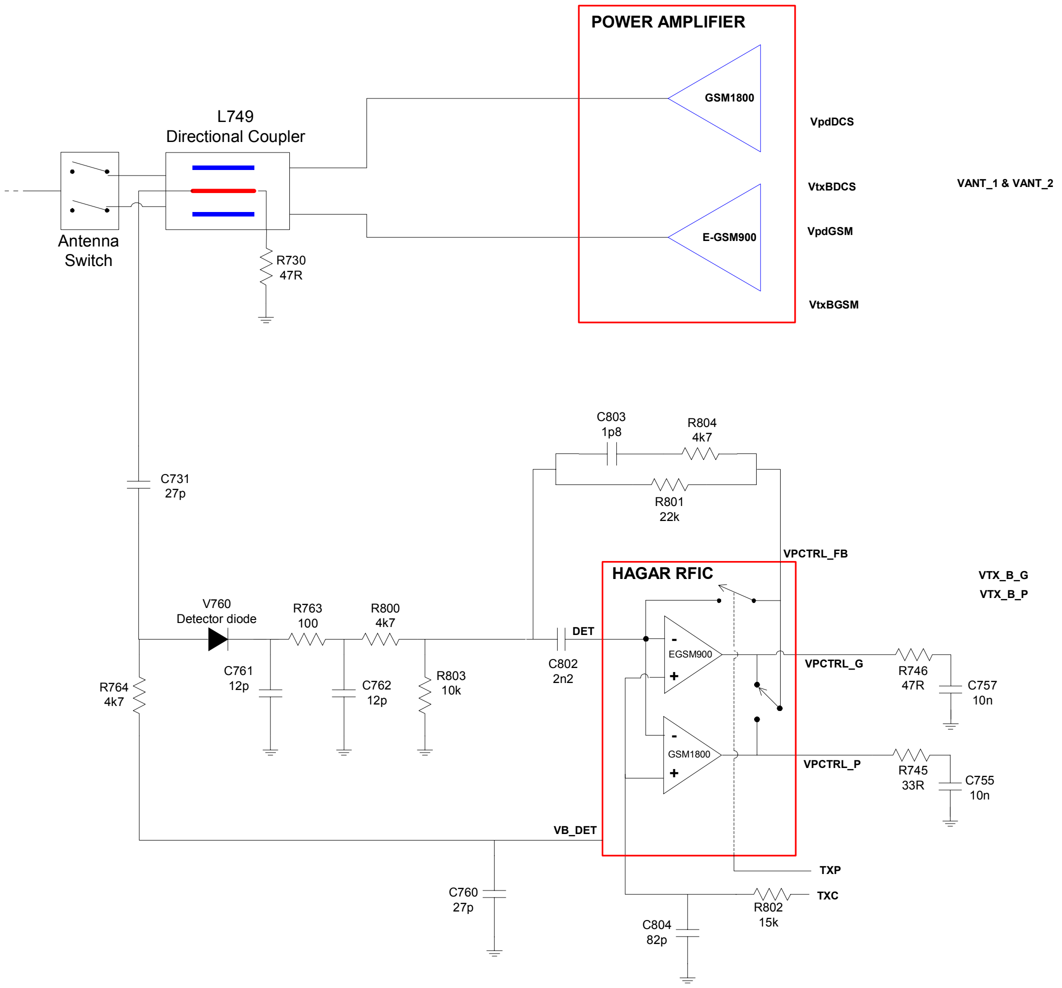
**Power control with analog temperature compensation scheme**

The detected voltage level is compared by the HAGAR internal error-amplifier to the current TXC voltage level, which is generated by a DAC in BB. The TXC line is a so-called 'raised cosine' shaped function, the effect of which is to minimize the switching transients during the power ramp/decay phase. Because the dynamic range of the detector is not wide enough to control the power ( more precisely, RF output voltage ) over the whole range, there is an additional control line named TXP to work below detectable levels. The burst is enabled and set to rise with TXP until such time as the output level is high enough for feedback loop to kick-in.

The feedback loop controls the output level via a control pin in PA to the desired output level and burst has got the waveform of TXC-ramps. Because feedback loops could be unstable, this loop is compensated with a dominating pole. This pole serves firstly to decrease gain of the error amplifier at higher frequencies which in turn increases the phase margin ( stability ). Secondly, it also provides for noise filtering on the TXC line.

Before power ramp the temperature information from detector is stored to $C_{temp}$. This temperature information is used during the burst to compensate power levels at different temperatures. The TXP signal enables the antenna switch module to TX mode. There are two separate power control loops in HAGAR, one for E-GSM900 and the other GSM1800.

**Figure 27: Power control feedback loop with analogue temperature compensation**



# Grip Module

## Abbreviations

| | |
|---|---|
| AEM | Auxiliary Energy Management |
| DC | Direct Current |
| GND | Ground |
| GPIO | General Purpose Input Output |
| HW | Hardware |
| IF | Inter Face |
| LED | Light Emitting Diode |
| MCU | Micro Controller Unit |
| P(0) | Column Port |
| P(1) | Row Port |
| PWB | Printed Wired Board |
| PWM | Pulse Width Modulation |
| SD_ | Shut Down (active low) |
| UEM | Universal Energy Management |
| UPP_WD2 | Universal Phone Processor Wireless Data 2 |

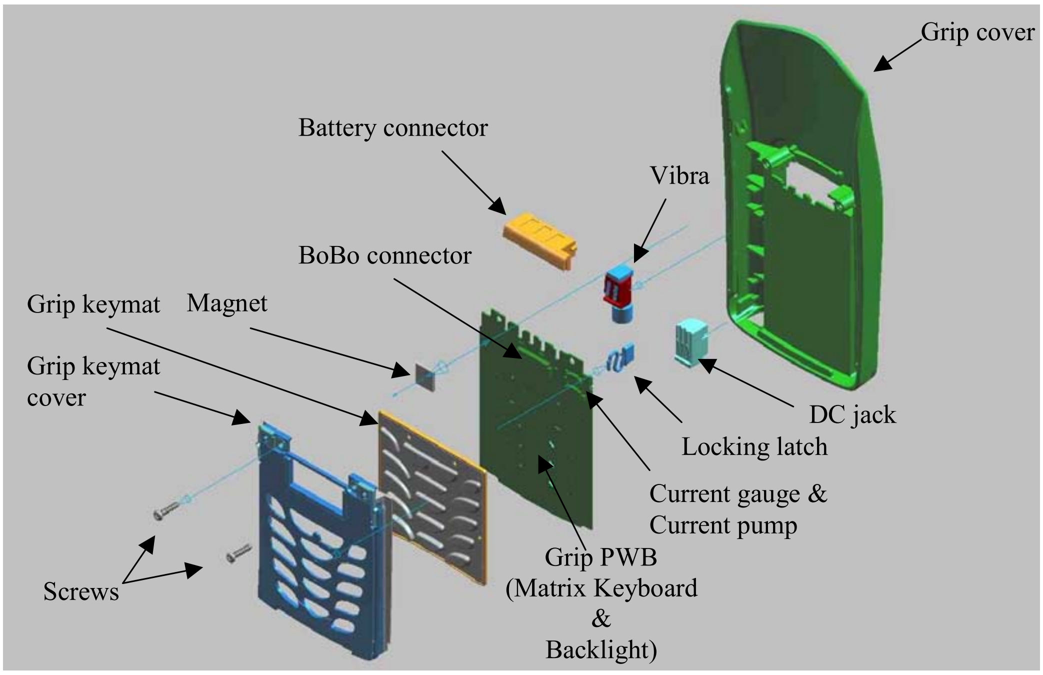
## Introduction

The grip consists of Matrix keyboard, Vibra, Current gauge, Current pump, Keyboard backlight LEDs, DC jack, Battery connector, Board to Board (BoBo) connector, Locking latch and magnet. There are five different versions of keymat; Latin, Stroke and BoPoMoFo. The figure shows the construction of the grip.

The Grip PWB consists of four layers. Dimensions of the PWB are 60 mm x 46 mm x 0.6 mm

Figure 28: **Construction of the Grip.**




All test pads are shown in a figure below. The pin numbers of the connector X001 are described in generally (1, 25, 26 and 50). Signals of the test pins can be seen on a next page.

**Figure 29: Board to board connector and the test pads shown from the top side**

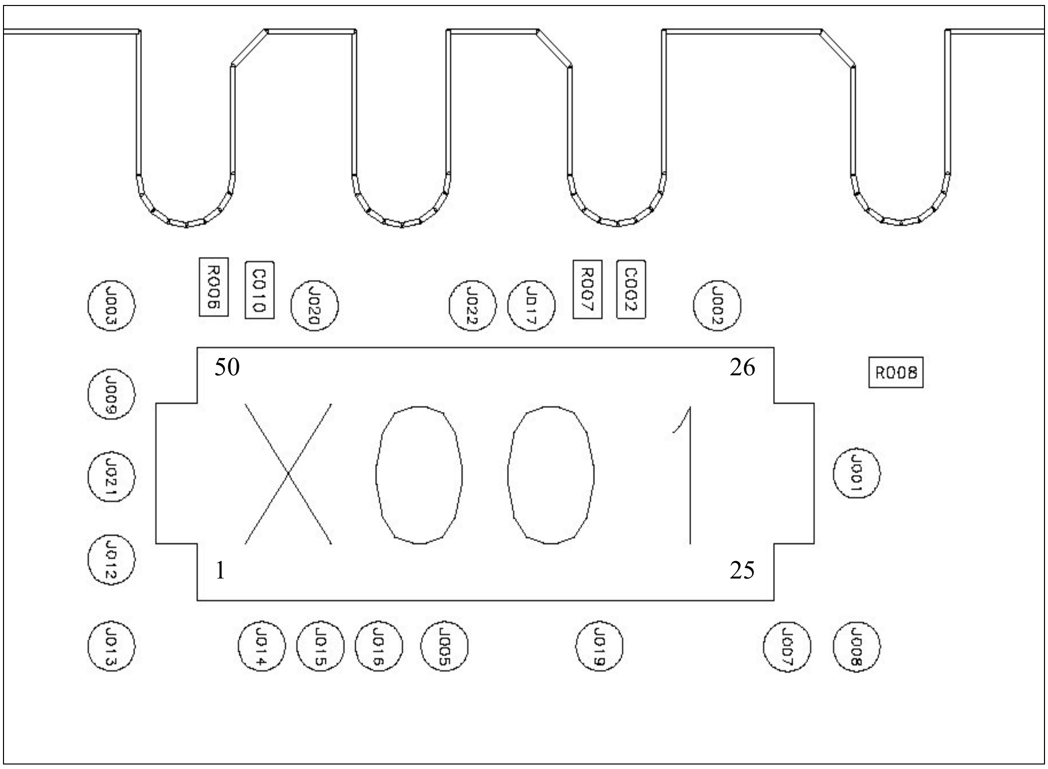
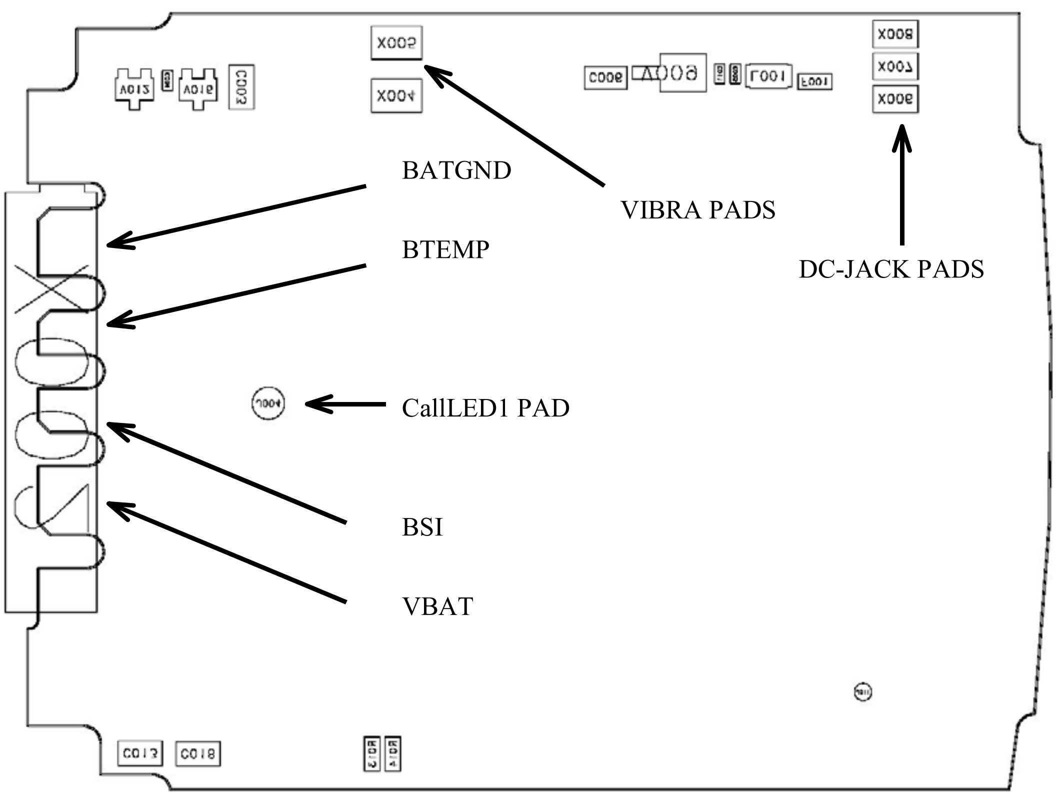


**Table 3: Signals and number of test pad**

| Signal | Test pad |
|---|---|
| Vbat | J001 |
| IPWM | J008 |
| ISD | J007 |
| VCHAR | J019 |
| BATGND | J020 |
| Col3 | J005 |
| Col2 | J016 |
| Row2 | J015 |
| Row3 | J014 |
| Row4 | J013 |
| Row5 | J012 |
| Called1 | J021 |
| Col4 | J009 |
| Btemp | J003 |
| Col5 | J022 |
| Vibra | J017 |
| BSI | J002 |

**Figure 30: Bottom side of the grip PWB**



## General Interface between Grip and Transceiver

*Note: The table below is for your convenience.*

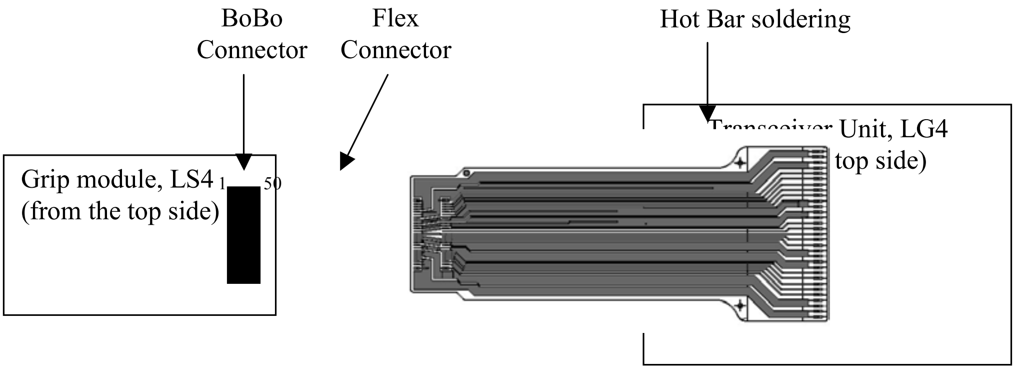
**Table 4: Signals between LG4 and LS4**

| Pin LG4 | Pin LS4 | Signal Name | Connected from-to | | Signal Properties (Typ.) A/D - Levels –FRQ./Timing resolution | | | Description / Note | MJS pin number |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 25 | BATGND | LG4 | LS4 | Ana | 0 | DC | Battery Ground | 25 |
| | 24 | | LG4 | LS4 | Ana | 0 | DC | | 24 |
| 2 | 23 | | LG4 | LS4 | Ana | 0 | DC | | 23 |
| | 22 | | LG4 | LS4 | Ana | 0 | DC | | 22 |
| 3 | 21 | VBAT | LS4/LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | Battery Voltage | 21 |
| | 20 | | LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | | 20 |
| 4 | 19 | | LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | | 19 |
| | 26 | | LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | | 50 |
| 5 | 27 | BSI | LS4 | LG4 | Ana | 0 - 2.7 V | DC | Battery Size indicator | 49 |
| 6 | 28 | BTEMP | LS4 | LG4 | Ana | 0 - 2.7 V | DC | Battery Temperature | 48 |
| 7 | 29 | IPWM | LS4 | LG4 | Ana | 0 - 2.7 V | DC | Current gauge Data | 47 |
| 8 | 30 | ISD | LG4 | LS4 | Ana | 0 - 4.2 V | DC | Current Gauge On Off | 46 |
| 9 | 31 | BATGND (CPWM) | LG4 | LS4 | Ana | 0 - 4.2 V | DC | Battery Ground (Charger Control PWM) | 45 |
| 10 | 32 | VCHAR | LG4 | LS4 | Ana | 0 - 4.2 V | DC | Charger Voltage | 44 |
| | 33 | | LG4 | LS4 | Ana | 0 - 4.2 V | DC | | 43 |
| 11 | 17 | | LG4 | LS4 | Ana | 0 - 4.2 V | DC | | 17 |
| | 18 | | LG4 | LS4 | Ana | 0 - 4.2 V | DC | | 18 |
| 12 | 34 | CGND | LG4<br>LG4<br>LG4<br>LG4 | LS4 | Ana | 0 | DC | Charger Ground | 42 |
| | 35 | | | LS4 | Ana | 0 | DC | | 41 |
| 13 | 15 | | | LS4 | Ana | 0 | DC | | 15 |
| | 16 | | | LS4 | Ana | 0 | DC | | 16 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 14 | 14 | VIBRA | LG4 | LS4 | Ana | 0 - 4.2 V | DC | Vibra Control | 14 |
| | 36 | | LG4 | LS4 | Ana | 0 - 4.2 V | DC | | 40 |
| 15 | 37 | COL5 | LS4 | LG4 | Dig | 0 - 1.8 V | DC | Keyboard Column signal | 39 |
| 16 | 38 | Called1 | LG4 | LS4 | Ana | 0 - 4.2 V | DC | Keyboard lights Control | 38 |
| | 13 | | | | | | | | 13 |
| 17 | 39 | Col2 | LS4 | LG4 | Dig | 0 - 1.8 V | DC | Keyboard Column Signal | 37 |
| 18 | 40 | Col3 | LS4 | LG4 | Dig | 0 - 1.8 V | DC | Keyboard Column Signal | 36 |
| | 12 | | | | | | | | 12 |
| 19 | 41 | VBAT | LS4/LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | Battery Voltage | 35 |
| | 42 | | LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | | 34 |
| 20 | 10 | | LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | | 10 |
| | 11 | | LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | | 11 |
| 21 | 43 | BATGND | LG4 | LS4 | Ana | 0 | DC | Battery Ground | 33 |
| | 44 | | LG4 | LS4 | Ana | 0 | DC | | 32 |
| 22 | 8 | | LG4 | LS4 | Ana | 0 | DC | | 8 |
| | 9 | | LG4 | LS4 | Ana | 0 | DC | | 9 |
| 23 | 45 | Row2 | LG4 | LS4 | Dig | 0 - 1.8 V | DC | Keyboard Row Signal | 31 |
| 24 | 46 | Row3 | LG4 | LS4 | Dig | 0 - 1.8 V | DC | Keyboard Row Signal | 30 |
| 25 | 47 | Row4 | LS4 | LG4 | Dig | 0 - 1.8 V | DC | Keyboard Row Signal | 29 |
| 26 | 48 | Row5 | LS4 | LG4 | Dig | 0 - 1.8 V | DC | Keyboard Row Signal | 28 |
| 27 | 49 | Col4 | LS4 | LG4 | Dig | 0 - 1.8 V | DC | Keyboard Column Signal | 27 |
| 28 | 5 | VBAT | LS4/LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | Battery Voltage | 5 |
| | 6 | | LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | | 6 |
| 29 | 7 | | LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | | 7 |
| | 50 | | LG4 | LG4/LS4 | Ana | 0 - 4.2 V | DC | | 26 |
| 30 | 1 | BATGND | LG4 | LS4 | Ana | 0 | DC | Battery Ground | 1 |
| | 2 | | LG4 | LS4 | Ana | 0 | DC | | 2 |
| 31 | 3 | | LG4 | LS4 | Ana | 0 | DC | | 3 |
| | 4 | | LG4 | LS4 | Ana | 0 | DC | | 4 |

Figure 31: As seen from the soldering pad side


Figure 32: General view of the connectors and a physical structure

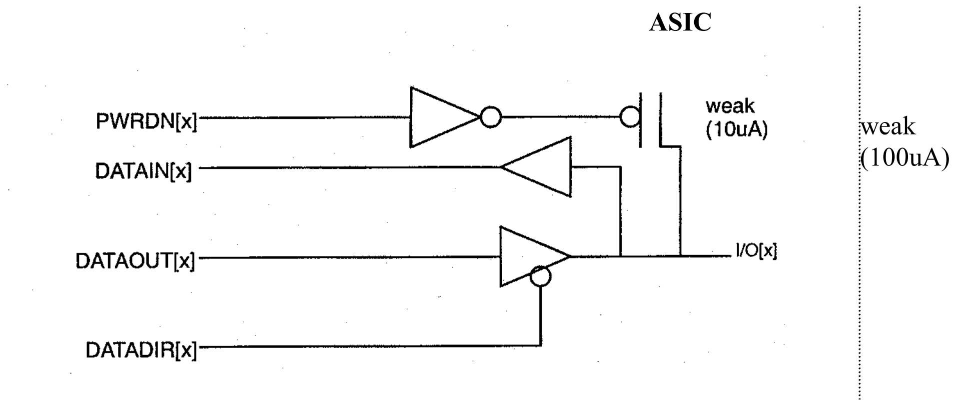


## Grip Keyboard

The grip keyboard interface requires 8 programmable GPIO pins, Figure 6. Construction of a GPIO in UPP_WD2. These pins can be configured as Inputs (ROW), Outputs (COLUMN). NHL-2NA is supporting 4x4 = 16 keys (ROWS X COLUMNS). NHL-2NA's grip uses 16 keys. The interface has a 4-bit row common I/O port (P1) and a 4-bit column common I/O port (P0) to fulfill the keyboard interface functions. The transceiver keyboard interface can be connected to UPP_WD2 with these 4+4 I/O-pins.

MCU performs the keyboard scanning.

**Figure 33: Construction of a GPIO in UPP_WD2**




*Note: Two keys can be pressed and noticed in any case.*

### Electrical implementation

**Figure 34: NHL-2NA's Grip keyboard implementation**

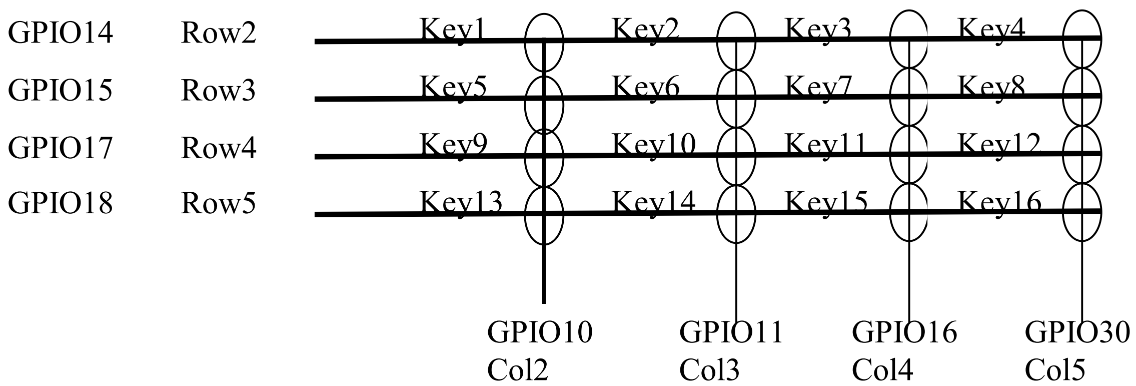



**Table 5: Specified keys**

| Key | Description |
|---|---|
| Key1 | ABC |
| Key2 | * |
| Key3 | # |
| Key4 | C |

| | |
|---|---|
| Key5 | 1 |
| Key6 | 2 |
| Key7 | 3 |
| Key8 | 0 |
| Key9 | 4 |
| Key10 | 5 |
| Key11 | 6 |
| Key12 | Send |
| Key13 | 7 |
| Key14 | 8 |
| Key15 | 9 |
| Key16 | End |

### Unit limits

**Table 6: Unit limits**

| Unit | Min. | Nom. | Max. |
|---|---|---|---|
| Pull up voltage, in UPP_WD2 (Measured from RowXX in) | 1.65 V | 1.8 V | 1.95 V |

## Vibra

The NHL-2NA grip module includes a vibra. The Nokia code is available in the spare part list.

## Electrical interface

Vibra needs one line from flex for operating. The line is VIBRA.

The VIBRA line is also connected to BATGND via 33nF and 2.2uF capacitors for filtering the interference. Capacitors locate near to the vibra. Vibra driver has also protective diodes (see Electrical interface of Vibra) because of inductive characteristic of the vibra.

The vibra component is controlled by UEM vibra driver.

**Figure 35:** Electrical interface of Vibra

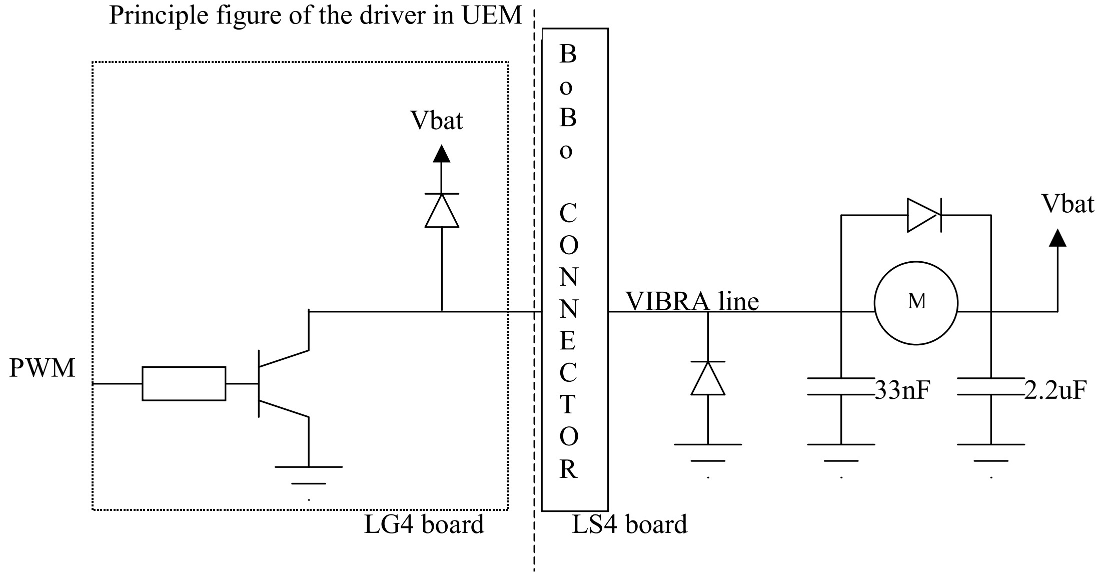
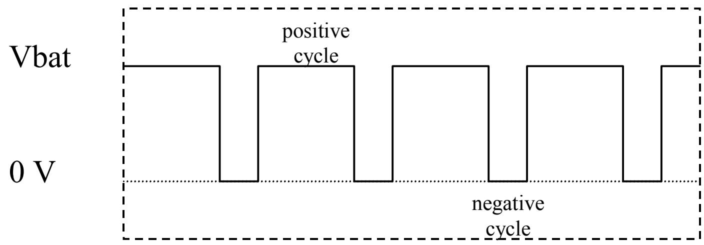



**Table 7: Electrical properties of the VIBRA signal**

| Unit | Min | Nom | Max |
|---|---|---|---|
| Current via vibra | 50 mA | 80 mA | 135 mA |
| Vbat | 3.0 V | 3.7 V | 4.2 V |
| Possible VIBRA signal frequency | 64Hz, 129Hz, 258Hz and 520Hz | | |
| VIBRA pulse duty cycle | 3% | 47% | 97% |

**Figure 36: Principle figure of the VIBRA signal**



## Current Gauge

The current gauge is placed to the positive battery line terminal so that all current flow in either direction is registered. See Electrical-implementation of the current gauge.

The LM3822 component is well suited for the purpose since its serial resistance is only 3 mW and it has a PWM output. The current value and direction are indicated by the duty cycle of the PWM signal. Shutdown is controlled with a specific pin.

**Table 8: Properties of the current gauge**

| Unit | Min | Nom | Max |
|---|---|---|---|
| Resistance<br>(between pins 1 and 8) | | 3 mΩ | |
| Current Range<br>(average) | - 1.0 A | | +1.0 A |
| Supply Voltage | 2.5 V | | 5.5 V<br>(Absolute Max) |
| Current consumption | | 2.5 uA (shut down)<br>90 uA (active) | |
| Cycle length<br>(average) | | 52 ms | |
| Package | MSOP-8 | | |
| BATGND | | 0 V | |
| Peak Current (200ms) | | | 10A<br>(Absolute Max) |

*Note: External components (2x100nF capacitors) are needed.*

### Interfacing the current gauge

AEM (locates on LG4) receives the PWM signal and calculates average duty cycle values to a register. SW can define how many PWM cycles are averaged, whether or not to give an interrupt to UPP_WD2 after averaging is done. The PWM value for the last PWM cycle can also be found out. The shutdown control is also through AEM. AEM gives an interrupt to UPP_WD2 indicating that current measurement is ready.

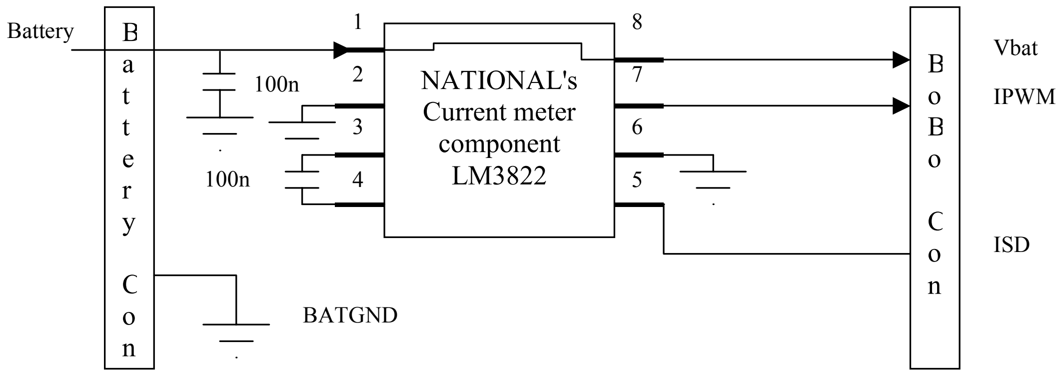
*Note: Shutdown control is used to disable and enable the gauge.*

**Table 9: Signal properties**

| Signal | Level | Polarity | I / O | to / from | Pin |
|---|---|---|---|---|---|
| Sense + / Vdd | | | | Vbat | 1 |
| BATGND | | | | Ground | 2 |
| Filter + | | | | ext. capacitor | 3 |
| Filter - | | | | ext. capacitor | 4 |
| ISD | Vbat | active Low | Input | AEM | 5 |

| | | | | | |
|---|---|---|---|---|---|
| TEST | | | | Ground | 6 |
| IPWM | Vbat | active HIGH | Output | AEM | 7 |
| Sense - | | | | Transceiver Vbat | 8 |

**Figure 37:** Electrical-implementation of the current gauge




*Note: BATGND is the ground of the grip, not charger ground*

## Backlight

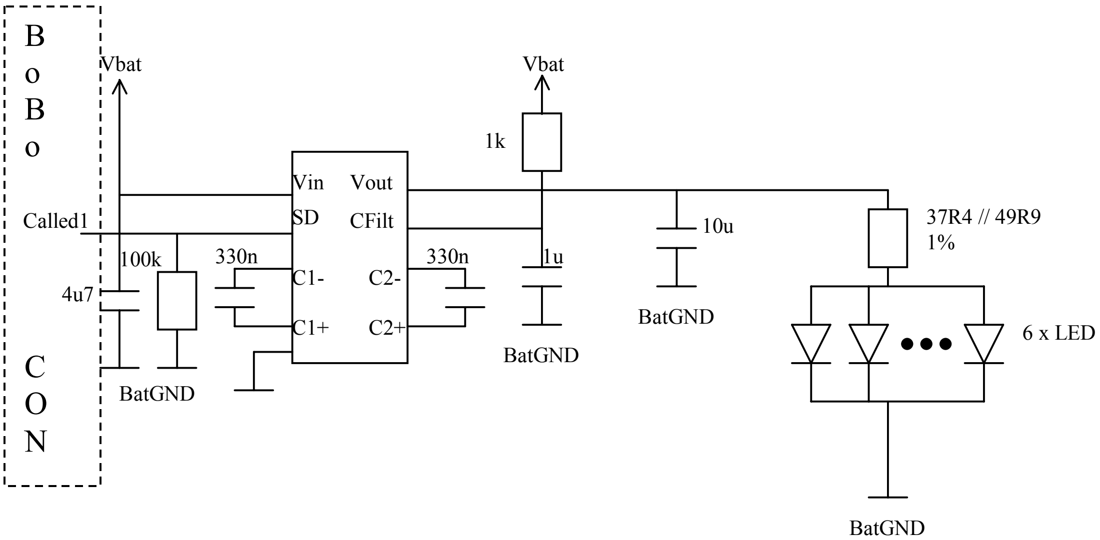
NHL-2NA grip keyboard uses six white backlight LEDs. These LEDs are "smart LEDs" (0.6mm height). The LED type is LWL88S, NMP code 4860331. NHL-2NA grip uses brightness groups M1-M2, N1-N2 and P1. There is only one brightness group in one grip-module.

### Electrical interface

The idea is to connect these six LEDs parallel. LEDs are using current that is taken from battery voltage. The voltage is controlled by charge pump (NMP code 4341137) and the current by serial resistor. The idea of the charge pump is to keep the supply voltage of the LEDs constant although Vbat changes. Serial resistors limit the current that goes to LEDs. Current for one LED is ~4mA. The circuit and LEDs consume ~52mA current.

LEDs need one line of flex (Called1). Called1 controls the charge pump SD pin. Called1 signal rises close to Vbat voltage (required for the SD signal in specification of the current pump). The output of the current pump is 4.1V (@Vbat 3.0V to 4.2V).

**Figure 38: Electrical implementation of the grip keyboard backlight**



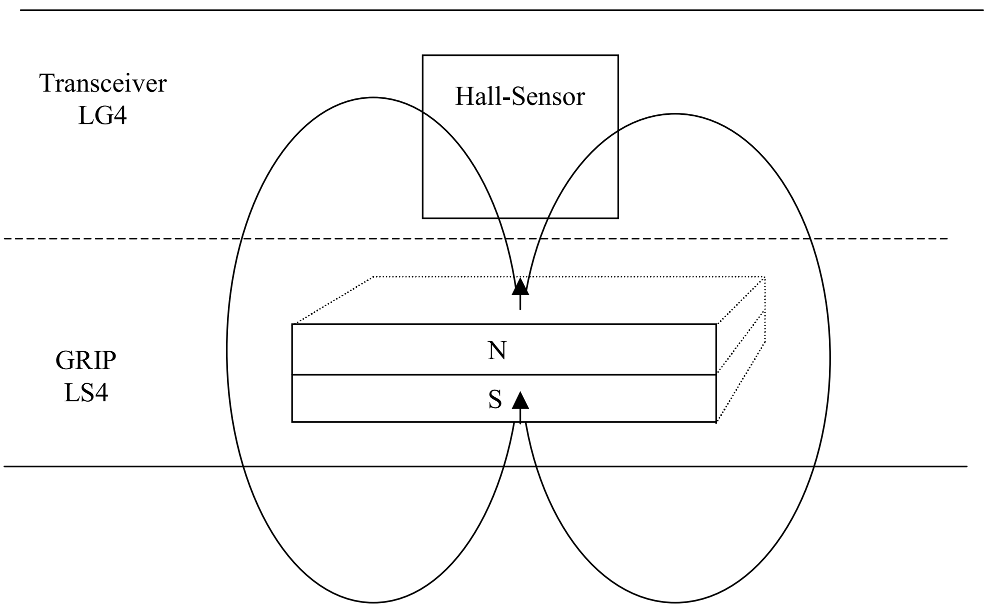
## Hall Sensor and Magnet

NHL-2NA uses the Infineon Hall sensor TLE 4917 (NMP code 4341087) and magnet to find out the open/close position of the grip. The hall sensor component is in the transceiver unit and the magnet is in the grip module. See figure 9 for more information.

### Magnet

NHL-2NA magnet (NMP code 6490201) locates on grip module.

**Figure 39: Basic principle of the hall-sensor implementation**




*Note: Hall sensor is independent on magnet flow direction, i.e. the magnet can be assembled in two ways; North-pole up or down.*

## DC Jack and Battery Connector

Grip has battery connector (NMP code 5400255), DC-jack (NMP code 5400251) and board to board connector (NMP code 5460059). Signals of the battery connector and DC jack are described in table below. See also Signals between LG4 and LS4. NHL-2NA uses BLB-2 battery.

*NOTE: Table below is for your convenience.*

**Table 10: Battery connector signals.**

| Connector | Signal | To | From | Value (BLB-2) |
|---|---|---|---|---|
| Battery | Vbat (sense) | Current Gauge | Battery con. | 3.2 V - 4.2 V |
| | Btemp | BoBo | Battery con. | 1979kΩ - 4.26 kΩ (- 40°C - + 90°C) |
| | BSI | BoBo | Battery con. | 68kΩ |
| | BATGND | BoBo | Battery con. | 0 V |

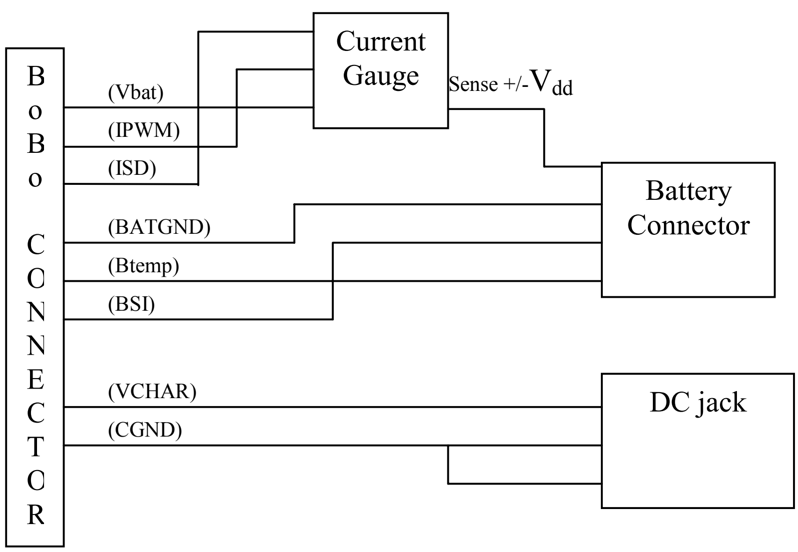
**Table 11: DC jack signals**

| Connector | Signal | To | From | Value (accepted charger) |
|---|---|---|---|---|
| DC jack | CGND | BoBo | DC jack. | 0 V |
| | VCHAR | BoBo | DC jack. | 5.0 V – 9.8 V |
| | CGND | BoBo | DC jack. | 0 V |

### Electrical interface

The basic principle of connections between connectors are described below.

**Figure 40: Figure 15. Electrical implementation of the connectors**



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# User Interface

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# User Interface

NHL-2NA user interface appearance is described below in fig.1. It comprises LG4 module and assembly parts.

## UI Module features

- 16-gray scale by PWM, 4096-color is available.
- Backlight unit is provided, so the display can be used in both reflective mode and transmissive mode.
- Direct data display by display data RAM (normally-white LCD)
  RAM bit data "1111" . . . OFF (minimum voltage) Red, green, blue
  "0000" . . . ON (maximum voltage) Black (in the normal display mode)
- Partial display function
  power saving by pausing display process on part of the screen.
- Built-in RAM capacity 4 x 648 x 240 = 622,080 bits.
- MPU interface.
  Directly connectable to an 8-bit parallel MPU, both 80 and 68 series
- A host of command functions (area scrolling, automatic page & column incrementing, and power controlling functions).
- Embedded oscillating circuit.
- User interface keys are provided.

**Table 1: Basic specifications**

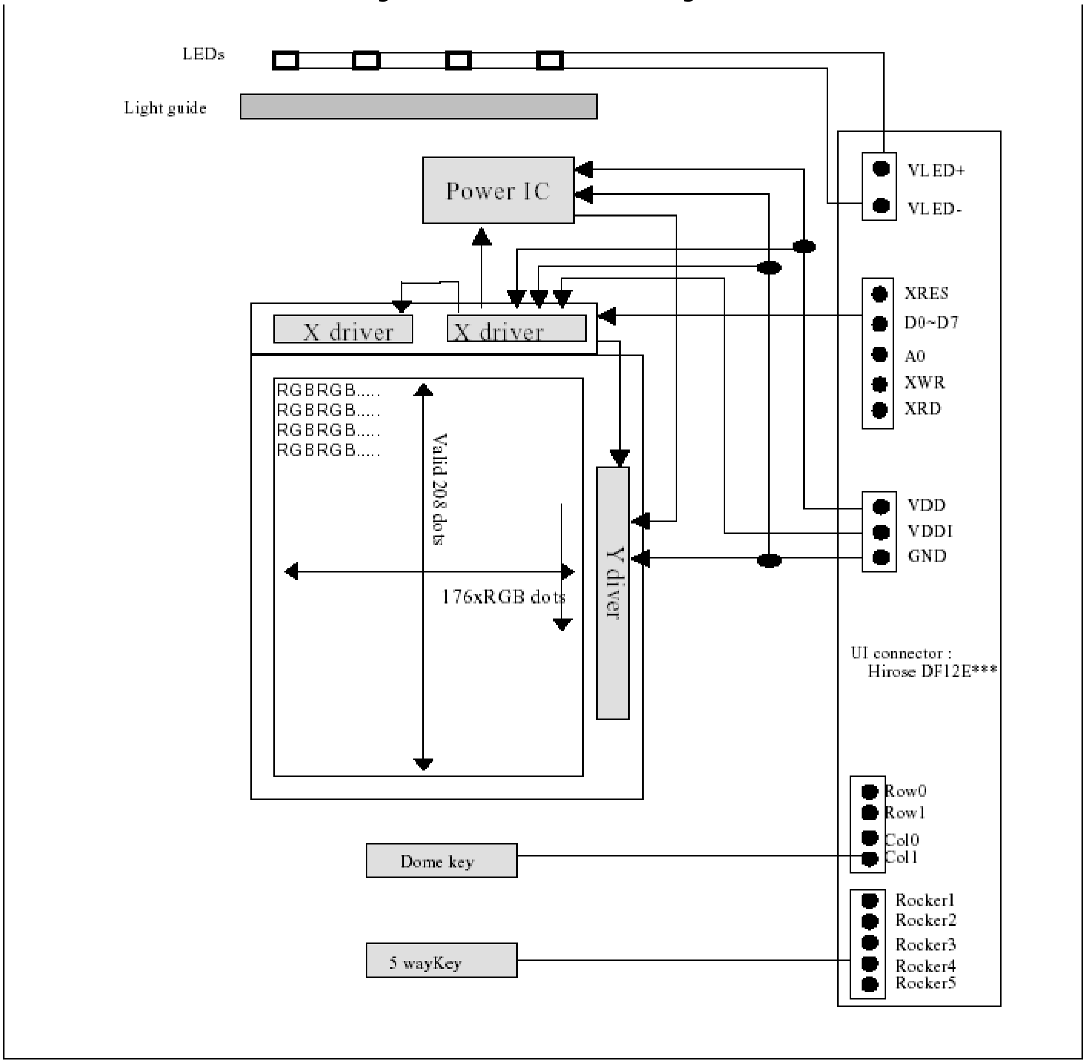
| No. | Item | Specifications |
|---|---|---|
| 1 | Outline dimensions (UI module) | 48.55 (W) x 79.44 (H) x 6.03 (D) mm (Excluding projections and FPC) |
| 2 | Weight | 17.5 g (UI module) |
| 3 | Screen dimensions | 34.86mm(W) x 41.18mm(H) |
| 4 | Display format | 176 x RGB (W) x 208 (H) |
| 5 | Dot pitch size | 66µm (W) x 198µm (H) |
| 6 | Color dot layout | Stripe |
| 7 | Contrast max direction | 7 o'clock (Transmissive)<br>2 o'clock (Reflective) |
| 8 | Polarizer direction | 1.5 o'clock |
| 9 | Image reversal direction | 4 o'clock |
| 10 | LCD mode | R-TN, Normally white (Transflective type) |
| 11 | Polarizers | Hard coated anti-reflective type |
| 12 | Polarizer hardness | 2H |

Figure 1: NHL-2NA user interface

## User Interface Module

UI Module comprises LCD, LCD drivers, LCD powering, LED backlightning, 5 way joystick, transceiver keyboard and voice key.

**Figure 2: UI module block diagram**



## I/O Terminals

**Table 2: UI connector**

| Terminal No. | Terminal Name | Function | I/O | Remarks |
|---|---|---|---|---|
| 1 | VDD | Power voltage | I | |
| 2 | GND | Ground | I | |
| 3 | D4 | Command/data I/O terminal | I/O | |
| 4 | D0 | Command/data I/O terminal | I/O | |
| 5 | A0 | Command/data identification signal input | I | "L" command/"H" data |
| 6 | GND | Ground | I | |
| 7 | VDDI | Power voltage | I | |
| 8 | D1 | Command/data I/O terminal | I/O | |
| 9 | D2 | Command/data I/O terminal | I/O | |
| 10 | D3 | Command/data I/O terminal | I/O | |
| 11 | Rocker3 | 5 way key | I | |
| 12 | Rocker2 | 5 way key | I | |
| 13 | GND-K | 5 way key Ground | I | |
| 14 | Rocker5 | 5 way key | I | |
| 15 | Rocker4 | 5 way key | I | |
| 16 | Rocker1 | 5 way key | I | |
| 17 | VLED+ | LED positive | I | |
| 18 | VLED- | LED negative | I | |
| 19 | Row1 | Dome key | I | |
| 20 | Row0 | Dome key | I | |
| 21 | Col1 | Dome key | I | |
| 22 | Col0 | Dome key | I | |
| 23 | GND | Ground | I | |
| 24 | XRES | Initial reset signal | I | "L" active |
| 25 | D5 | Command/data I/O terminal | I/O | |
| 26 | D6 | Command/data I/O terminal | I/O | |
| 27 | D7 | Command/data I/O terminal | I/O | |
| 28 | GND | Ground | I | |
| 29 | XRD | Read signal | I | "L" active |
| 30 | XWR | Write signal | I | "L" active |

## Sub-modules of User Interface

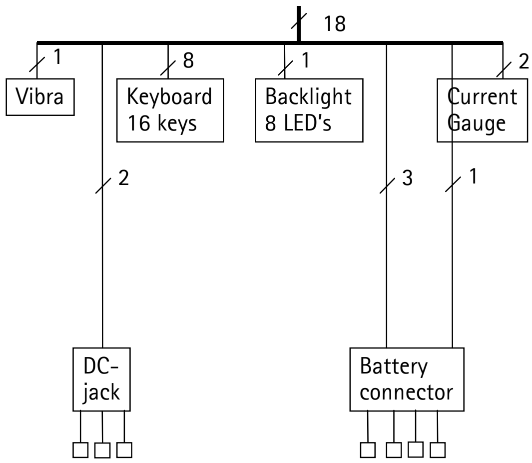
User Interface electronics comprises the following:

### Grip module

Grip module includes the keyboard with its PWB and backlight, the vibrator.

Battery is also included in this module

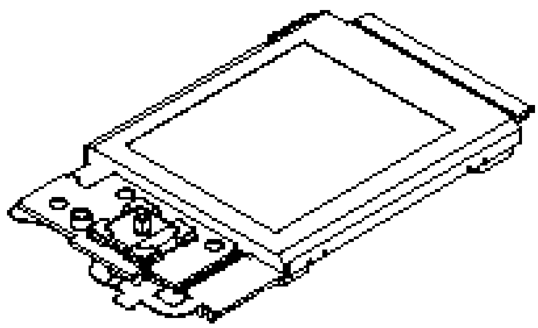
**Figure 3: Grip module**




### LCD module

UI Module is an entity containing the display module, backlighting, 5 way navigation key and transceiver keys.

**Figure 4: LCD Module**



## Absolute Maximum Ratings

**Table 3: Absolute maximum ratings**

| Item | Symbol | Rating | Unit | Terminal |
|---|---|---|---|---|
| Power supply voltage | $V_{DD}$ | 0 ~ +3.3 | V | VDD |
| | $V_{DDI}$ | 0 ~ +3.3 | V | VDDI |
| Signal input voltage | $V_{IN}$ | 0 ~ $V_{DDI}$+0.3 | V | D0~D7 |
| Signal output voltage | $V_{OUT}$ | 0 ~ $V_{DDI}$+0.5 | V | D0~D7, A0, XRES, XRD, XWR |
| LED input voltage | $V_{LED}$ | 6 | V | Between VLED+ and VLED- |
| Operating temperature range | $T_{OP}$ | -20 ~ 70 | C | No dew condensation |
| | | -30~-20 | C | No dew condensation<br>Reduced optical performance |
| Storage temperature range | $T_{ST}$ | -40 ~ 85 | C | No dew condensation |

Note: values respect to UI module GND

## DC Characteristics

UI connector is the connector between the UI module and NMP PWB.

**Table 4: UI-connector DC characteristics**

| Pin no. | Signal name | Type | Min | Typical | Max | Unit | Description |
|---|---|---|---|---|---|---|---|
| 1 | VDD | IN | 2.6 | 2.78 | 2.9 | V | Voltage supply |
| 2 | GND | | | 0 | | V | System ground |
| 3 | D4 | IN | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | Data to write |
| | | OUT | H: 0.8xVDDI<br>L: 0 | | H: VDDI<br>L: 0.2 x VDDI | V | Data to read |
| 4 | D0 | IN | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | Data to write |
| | | OUT | H: 0.8xVDDI<br>L: 0 | | H: VDDI<br>L: 0.2 x VDDI | V | Data to read |
| 5 | A0 | IN | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | H: data<br>L: command |
| 6 | GND | | | 0 | | V | System ground |
| 7 | VDDI | IN | 1.65 | 1.8 | 1.95 | V | Logic voltage supply |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | D1 | IN | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | Data to write |
| | | OUT | H: 0.8xVDDI<br>L: 0 | | H: VDDI<br>L: 0.2 x VDDI | V | Data to read |
| 9 | D2 | IN | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | Data to write |
| | | OUT | H: 0.8xVDDI<br>L: 0 | | H: VDDI<br>L: 0.2 x VDDI | V | Data to read |
| 10 | D3 | IN | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | Data to write |
| | | OUT | H: 0.8xVDDI<br>L: 0 | | H: VDDI<br>L: 0.2 x VDDI | V | Data to read |
| 11 | Rocker3 | | | 200 | | mOhm | |
| 12 | Rocker2 | | | 200 | | mOhm | |
| 13 | GND | | | 0 | | V | System ground |
| 14 | Rocker5 | | | 200 | | mOhm | |
| 15 | Rocker4 | | | 200 | | mOhm | |
| 16 | Rocker1 | | | 200 | | mOhm | |
| 17 | $V_{LED}$+ | IN/<br>OUT | | 4.5 | | V | LED, positive ter-<br>minal |
| 18 | $V_{LED}$- | IN/<br>OUT | 0 | 0 | Vbat | V | LED, negative<br>terminal |
| 19 | Row1 | IN/<br>OUT | | | 1 | Ohm | Tracking resist-<br>ance |
| | | | | | 1 | mA | Drive current |
| 20 | Row0 | IN/<br>OUT | | | 1 | Ohm | Tracking resist-<br>ance |
| | | | | | 1 | mA | Drive current |
| | | | | | 1 | mA | Drive current |
| 21 | Col1 | IN/<br>OUT | | | 1 | Ohm | Tracking resist-<br>ance |
| | | | | | 1 | mA | Drive current |
| 22 | Col0 | IN/<br>OUT | | | 1 | Ohm | Tracking resist-<br>ance |
| | | | | | 1 | mA | Drive current |
| 23 | GND | | | 0 | | V | System ground |
| 24 | RESX | IN | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | Reset<br>(active low) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 25 | D5 | IN<br>OUT | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | Data to write |
| | | | H: 0.8xVDDI<br>L: 0 | | H: VDDI<br>L: 0.2 x VDDI | V | Data to read |
| 26 | D6 | IN<br>OUT | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | Data to write |
| | | | H: 0.8xVDDI<br>L: 0 | | H: VDDI<br>L: 0.2 x VDDI | V | Data to read |
| 27 | D7 | IN<br>OUT | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | V | Data to write |
| | | | H: 0.8xVDDI<br>L: 0 | | H: VDDI<br>L: 0.2 x VDDI | V | Data to read |
| 28 | GND | | | 0 | | | System ground |
| 29 | RDX | IN | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | | L: read<br>(active low) |
| 30 | WRX | IN | H: 0.7xVDDI<br>L: 0 | | H: VDDI<br>L: 0.3xVDDI | | L: Write<br>(active low) |

**AC Characteristics of the Display**

Signal timings are shown in Figure 7. Read/write characteristics and Table 10. AC characteristics. All the characteristics in this chapter are specified for the whole UI module, including the UI-FPC.

Notes: Rise and fall time must be within 20 ns. Timings of $T_{ACC8}$ and $T_{OH8}$ are according to 20% and 80% VDDI-GND. Other timings are according to 30% and 70% of VDDI-GND. $t_{CCLW}$ and $t_{CCLR}$ are specified according to overlapping of low level periods of CSX and WRX (RDX).

Definitions to rise and fall times as described in Figure 8. Rise and fall time in input and output and Rise and fall times in input and output of display driver.

**Figure 5:** Rise and fall time in input and output

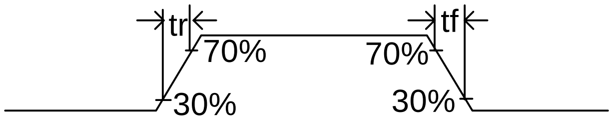


**Table 5: Rise and fall times in input and output of display driver**

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Input | tr, tf | | 20 | ns |
| Output | tr, tf | | 20 | ns |

## Display Functional Specification

### Displayed Data

Pixel and dot ordering in parallel transfer from engine to display is shown in Figure 9. Pixel and dot order in transfer. Three bytes (RG, BR and BG) are needed to send data of two pixels, as data of one pixel is 12 bits. Corresponding order in panel is shown in Figure 10. Pixel data order in display panel.

### Reset Timing

Reset timing characteristics are shown in Figure 11. Reset timing and Reset timing. All the characteristics in this chapter are specified for the whole UI module, including the UI-FPC.

**Table 6: Reset timing**

| Signal | Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|---|
| RESX | TRW | Reset pulse duration | 200 | | ns |
| | TRT | Reset cancel | 1200 | | ns |

## Transceiver keyboard

The transceiver keyboard Interface requires 4 programmable I/O pins. The transceiver keyboard interface can be connected to Nokia Engine with these 2 + 2 I/O-pins. T

| Key | Description |
|---|---|
| Key1 | Left_Soft_Key |
| Key2 | Right_Soft_Key |
| Key3 | Apps Key |
| Key4 | Side Key |

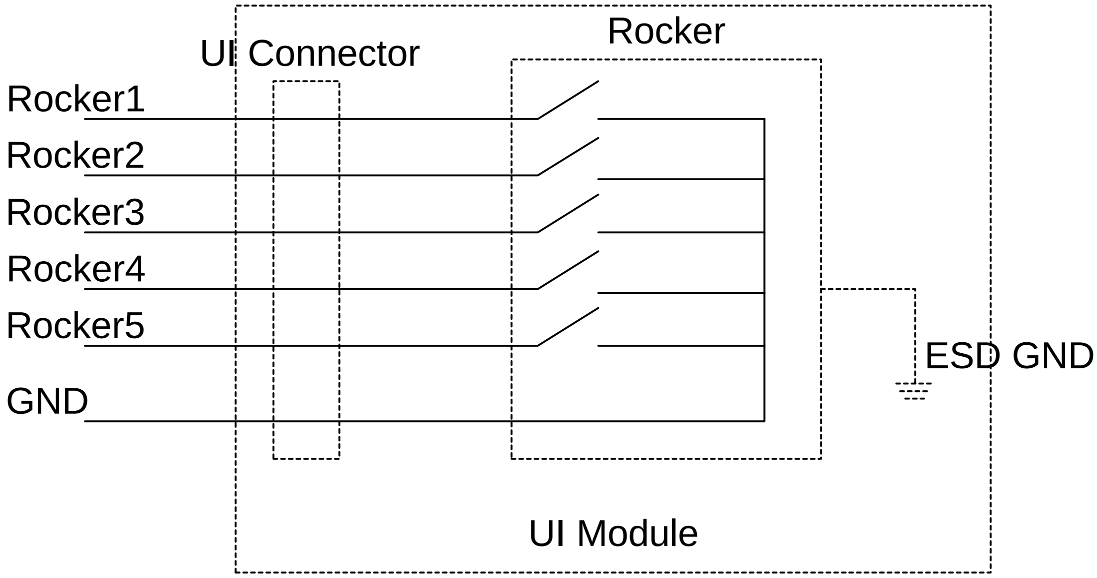
## Rocker key

The rocker key is a replaceable part.

### Rocker interface

Rocker is connected to general purpose IOs that have internal pull ups. Pull up voltage is 1.8V.

**Figure 6:** Electrical interface of the rocker




Rocker is operated as a switch in an ideal case. In reality more than two pins can be connected to ground with one move.

**Figure 7: Rocker switch 2**

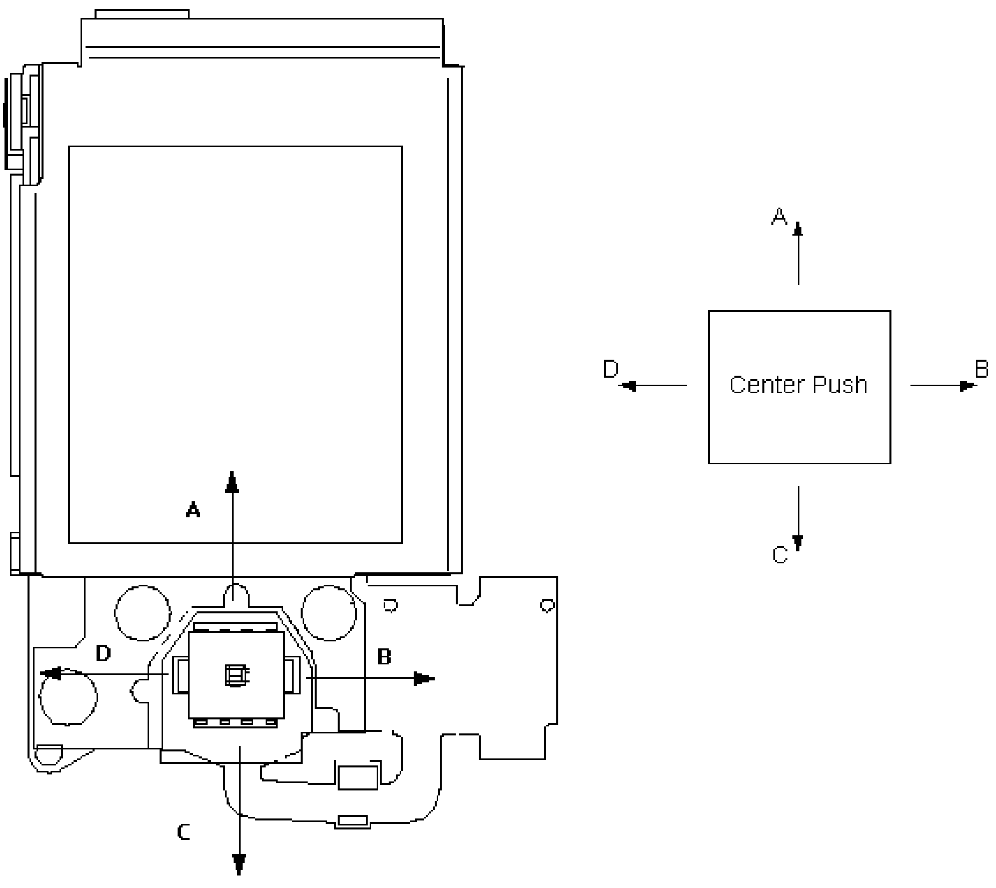


**Table 7: Switching order of the terminals**

| Leaning direction | Terminal number | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **Com** |
| A | | | | * | | * |
| B | * | | | | | * |
| C | | * | | | | * |
| D | | | * | | | * |
| Center push | | | | | * | * |

# Camera Module

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## Abbreviations

| | |
|---|---|
| VGA | Video Graphic Array |
| CIF | Common intermediate format |
| CCI | Camera Control Interface |
| LVDS | Low voltage differential signals |
| CCP | Compact camera port |
| CDS | Correlated double sampling |
| AGC | Automatic gain control |
| ADC | Analog digital converter |
| TG | Timing generator |
| SG | Synchronization generator |
| PLL | Phase locked loop |
| VCO | Voltage control oscillator |
| AWB | Automatic white balance |
| AES | Automatic electronics shutter |

# Camera Module

## Key specification

The table below shows the key specification of the VGA2 camera module (TCM8002MD).

**Table 1: Key specification**

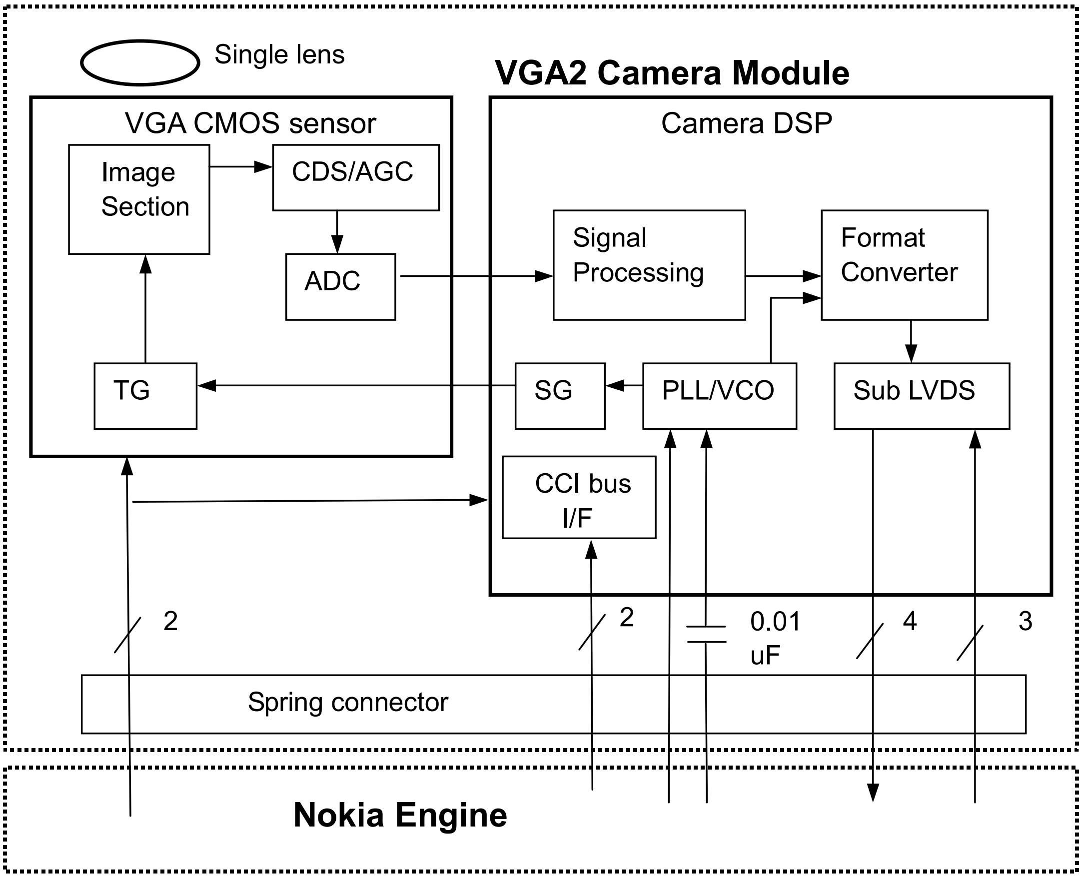
| | | |
|---|---|---|
| Image sensor | Array format | active: 660 H x 492 V |
| | color filter | RGB bayer arrangement |
| | Optical format | 1/4 " |
| | pixel size | 5.4 um |
| lens | F no. | 2.8 |
| | H view angle | 53 degrees(H) / 39(V) / 65(D) |
| | focal length | 3.5 mm |
| | focus range | 30 cm to infinity |
| | focus adjustment | Object distance for adjustment is infinity. |
| Interface | image signal output | CCP ( sub LVDS serial output) |
| | output image format | YUV 4:2:2, RGB 5:6:5, sensor 10 bit raw data |
| | image size | A variety of size is supported. See table 6 |
| | frame rate | typical : 15 fps |
| | master clock | External clock is supplied. |
| | control interface | CCI bus |
| | mechanics | 13-pin spring connector |
| Power source | VDD=DC 2.78 +/- 0.13 V and VDDI =DC 1.8 +/- 0.1 | |
| Current consumption | VDD on & VDDI | 34 mA typical for VDD, 7 mA typical for VDDI |
| | VDD off & VDDI | 1 uA |
| Dimension | 16 mm (H) x 20 mm ( W) x 8.9 mm (D) excluding protrusion of connector | |
| Weight | | 1.6 gram |
| Temperature range | operation | -30 to + 70 centigrade |
| | full quality | -10 to + 40 centigrade |
| | storage | -40 to + 85 centigrade |

## Electrical specifications

### Block diagram

The figure below shows the block diagram of the VGA2 camera module connected to Nokia Engine.

**Figure 1: Block diagram of camera module**




## Signal description

The following description indicates the meaning of each signal shown in figure above.

| | |
|---|---|
| (1) VDD | Supply voltage to the main circuits of a camera module |
| (2) GND2 | Ground line corresponding to VDD |
| (3) D + | Fast serial data out |
| (4) VDDI | Supply voltage to sub LVDS circuit. This voltage can be always applied, even if the Vctrl is off. |
| (5) D - | Fast serial data out of which is inverted to D+ |
| (6) SDA | Serial data line of CCI bus |
| (7) GND1 | Ground line corresponding to VDDI |
| (8) SCL | Serial clock line of CCI bus |
| (9) Clk + | Fast serial clock |
| (10) Vctrl | This signal is used for sub LVDS circuit to be shut off in order to reduce stand-by current of a camera module. "High" designates "ON". Please see the operation flow chart. |
| (11) Clk - | Fast serial data out of which is inverted to Clk+ |
| (12) GND3 | Ground line corresponding to Extclk. |
| (13) Extclk | System clock from Nokia engine to the camera module. This signal is sinusoidal by RC filtering on Nokia engine. Extclk is AC coupled to the camera module through a capacitor of which capacitance is more than |

0.01 uF. Extclk has 4 operating modes depending on the wireless system in which the camera module is used. The Extclk is active before VDD is on. This Extclk shall be exclusively used for generating any other clocks

**DC characteristics**

(1) Maximum ratings

| | |
|---|---|
| VDD | 3.6 V |
| VDDI | 2.7 V |
| Input signals, min | -0.3 V |
| Input signals, max | VDDI (1.8V) + 0.3 V |

Note: Values respect to GND.

(2) DC characteristics of each signal are shown in the table below.

**Table 2: DC characteristics of each signal**

| Signal name | Type | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| VDDI | IN | 1.7 | 1.8 | 1.9 | V |
| VDDI current*2 consumption | | -- | 7 | 10 | mA |
| D+,D-, Clk+,Clk | OUT | VDDI/2 - 0.1 | VDDI/ | VDDI/2 + 0.1 | V |
| | | 1 | 104 | 120 | MHz |
| ExtCl | IN | 0.5 | 1 | 1.2 | V peak-peak |
| | Mode | 6.45/12.9 | 6.5/13.0 | 6.55/13.1 | MHz |
| | Mode | 9.55/19.1 | 9.6/19.2 | 9.65/19.3 | MHz |
| | Mode | 8.35/16.7 | 8.4/16.8 | 8.45/16.9 | MHz |
| | Mode | 9.67/19.34 | 9.72/19.44 | 9.77/19.54 | MHz |
| | The wave shape is sinusoidal by applying LPF in a host | | | | |
| SDA, SCL | IN/OUT | 0.3*VDDI | - | 0.7*VDDI | VIL, VIH |
| VDD | IN | 2.65 | 2.78 | 2.91 | V |
| Stand-by Current(*1) | ExtClk open | -- | 1 | 5 | uA |
| | ExtClk 500mVpp | -- | 1 | 5 | uA |
| VDD current*2 consumption | | -- | 34 | 40 | mA |
| Vctr | IN High | VDDI x 0.7 | -- | VDD | V |
| | IN Low | 0 | -- | VDDI x 0.3 | V |

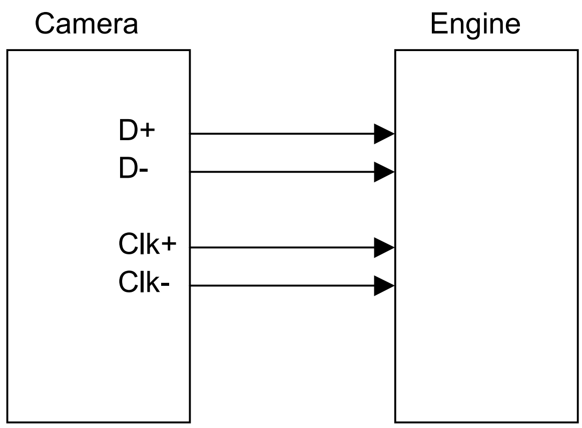
*1 Measuring conditions of typical value
VDD Off, VDDI 1.8V On, VCtrl Off, ExtClk Open or 500mVp-p, Temperature 25C
Lens capped.

## Signals specifications

### Signals and timing

The fast serial interface of digital image data is employed for the VGA camera module. The fast serial interface described in this document is named CCP (Compact Camera Port). In terms of signaling scheme, CCP is based on the idea of IEEE standard LVDS signaling scheme (current mode differential low voltage signaling method). CCP described in this document utilizes lower voltage than that of standard LVDS. The low voltage LVDS is named in this document sub LVDS. CCP is an one-way differential serial camera connection with clock and integrated line / frame synchronization:

**Figure 2: CCP interface between camera and engine**




D+ and D- are differential picture data output from the camera module. This data is written on each falling edge of **Clk**. Data format is least significant bit first. When nothing is being transferred, **D** remains high, except in power shut-down.

Clk+ and Clk- are differential pixel clock. Data should be read by the receiving end on rising edge. When nothing is being transferred, **Clk** remains high, except in power shut-down.

The figure below shows the basing timing between D and Clk schematically. In the table below the AC characteristics in D and Clk relation are shown.

**Figure 3: Basic bus timing**

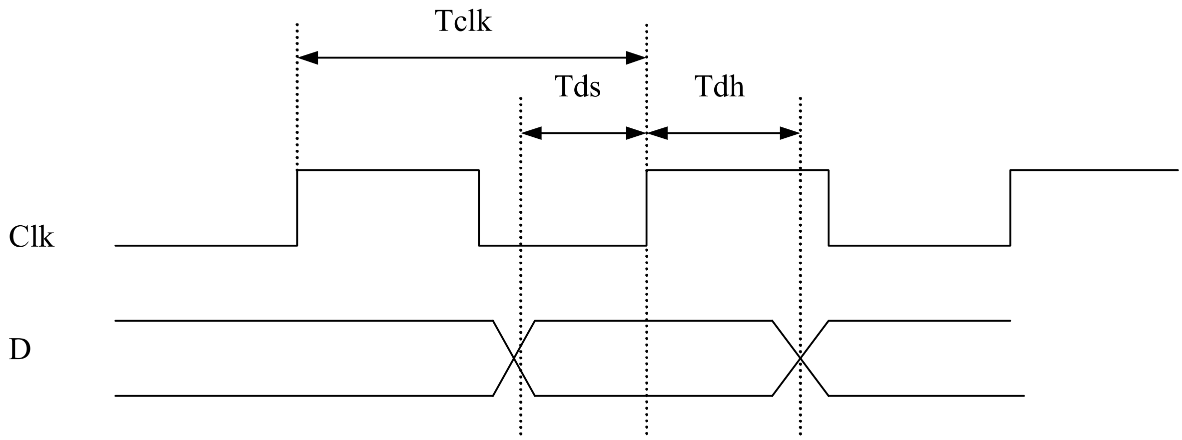


**Table 3: AC timing between D and Clk**

| Parameter | Abbreviation | Min time | Max time |
|---|---|---|---|
| Bus clock cycle | **T**clk | 8.3 ns (120MHz) | 1000 ns (1 MHz) |
| Data set-up time before **Clk** rising | **T**ds | 1ns | |
| Data hold time | **T**dh | 2 ns | |

| | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Clk duty | 40/60 | 50/50 | 60/40 | % |

## Synchronization

Each image line that is received begins with line synchronization code and ends with line end code. Each frame begins with frame synchronization code and ends with frame end code. At frame start and frame end no line synchronization are added but they are replaced by the frame synchronization.

## Image formats and frame rate

The table below shows the relationship between Extclk and CCP frequency to keep the frame rate constant (approximately 15 fps). Each mode on the table below can be selected by CCI bus command setting from Nokia engine.

**Table 4: Frequency relationship for each Extclk (VGA image)**

| Mode | Extclk | CCP frequency | Pixel clock | Number of Pixel clock per H | Frame rate |
|---|---|---|---|---|---|
| | MHz | MHz | MHz | | fps |
| 1 | 6.5/13.0 | 104.0 | 6.50 | 828 | 14.952 |
| 2 | 9.6/19.2 | 115.2 | 7.2 | 916 | 14.972 |
| 3 | 8.4/16.8 | 100.8 | 6.30 | 802 | 14.962 |
| 4 | 9.72/19.44 | 116.6 | 7.29 | 928 | 14.962 |

The table below shows image size format of the respective image made from the original full VGA. Each CCP frequency shown on the table below designates the ratio to CCP frequency of full VGA at 15 fps.

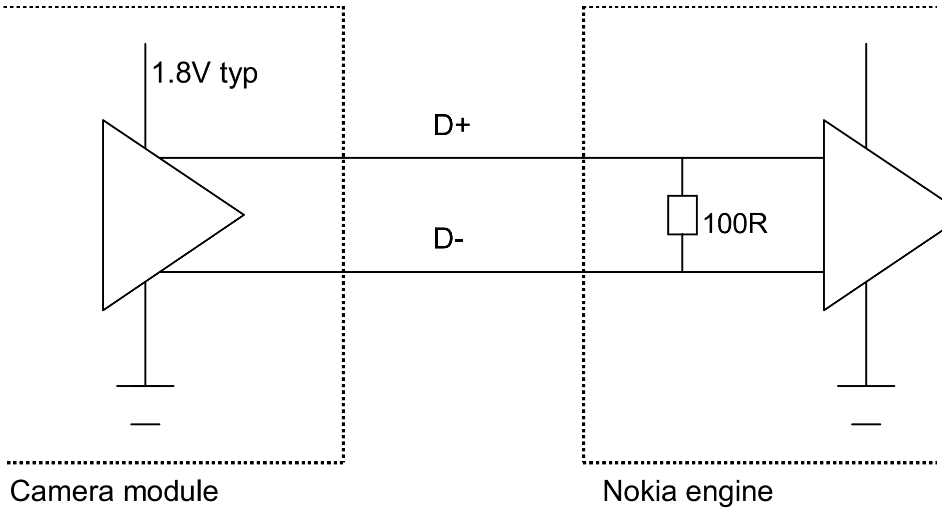
In case of subsampling QVGA, subsampling QQVGA and subsampling QCIF, 30 fps operation is supported as well as 15 fps. In this case, CCP frequency becomes twice.

## Sub LVDS specification

### General

The fast serial transfer of image data from the camera module to Nokia engine is to be achieved based on 1.8 power supply condition. Accordingly, modified LVDS type current mode transmitters/receivers is used. In this document, the LVDS scheme which is modified corresponding to 1.8 V is named sub LVDS. The figure below shows simplified configuration of sub LVDS

**Figure 4: sub LVDS configuration**




DC, AC characteristics

DC characteristics, AC characteristics (transmitting end) and (receiving end) are shown in the tables below.

**Table 5: DC characteristics**

| Item | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Bus operating voltage VDDI | 1.7 | 1.8 | 1.9 | V |
| Absolute maximum rating | - 0.3 | | VDDI + 0.3 | V |

**Table 6: AC characteristics of camera module**

| **Parameter** | **Signal level** | | | |
|---|---|---|---|---|
| | Min | Typical | Max | |
| Input voltage range | VDDI/2-0.1 | VDDI/2 | VDDI/2+0.1 | V |
| Differential voltage swing Vod | 100 | 150 | 200 | mV |
| Output impedance R0 | 40 | 100 | 140 | Ohm |
| Operating frequency | 1 | | 120 | MHz |
| Clock duty cycle @ 120 MHz | 40 | 50 | 60 | % |
| Vod rise time 20% - 80% | 300 | | 500 | ps |
| Vod fall time 80% - 20% | 300 | | 500 | ps |

*Note: Vod is measured with 100 ohm termination.*

## Camera control interface

### General

The camera control interface configuration is based on fast mode IIC(i.e. $I^2C$) bus.

**Slave address**

The Camera Module control interface has got slave address 78h. General call address and start byte are not supported.

Sub address

A sub address for internal register are prepared. Width of sub address is 8 bits, and each address has 8 registers. The camera module has the function of increment addressing, the host can operate continuous addresses by one sequence. After system reset by Power ON (when VDD is applied) subaddress becomes 00'h.

**Read & write**

Nokia engine can read and write all registers' data except for test registers.

## Operating procedure

### Mode description

This camera module supports following two operating modes.

1. Normal mode
   This mode means continuous image capturing operation.
   (Namely every frame is output.)
2. Long storage mode
   This mode means intermittent image capture operation (one frame out of every four frame) particularly in case of long time exposure. Nokia engine submits a command to set this mode.

### Operation flow chart

(1) For Power-on, the following order is necessary.

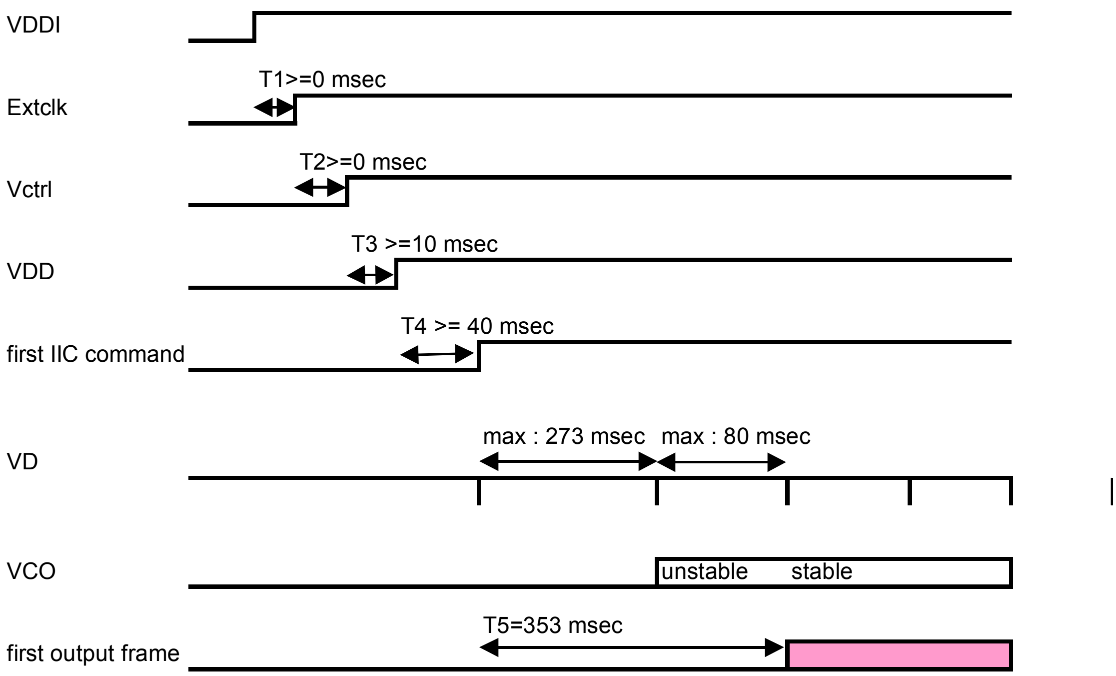
VDDI(1.8 V) power ON $\xrightarrow{T1}$ Extclk ON $\xrightarrow{T2}$ Vctrl ON $\xrightarrow{T3}$ VDD(2.8 V) Power ON $\xrightarrow{T4}$ Command for initializing $\xrightarrow{T5}$ Image data output start.

The camera has default values of parameters for start-up action. The host can change the parameter values by sending the parameter value via CCI bus. In this case these changed values are not memorized in the camera module because no EEPROM is provided inside.

Accordingly. after power-off, the host must send the values again if the same operation is necessary. The necessary time interval for moving to the next operation is listed in Figure 9. For the external clock of 6 MHz (lowest), the pixel clock becomes 1.5 MHz (without VCO). In this case, one vertical scanning period is 273 msec t the maximum value).

In the figure below, "VD" is internal synchronization pulse to show vertical scanning period.

Figure 9. operation sequence in power-on




(2) For Power-off

VDD(VDD2.8 V) → Vctrl OFF → Extclk OFF → OFF VDDI (1.8 V) OFF
T1>=0 T2>=0 T3>=0

## Mechanics

Mechanics drawing in the file of "TCM8002MD external view.pdf".

The camera module has got a plastic lens holder with a metallized surface. The lens barrel part does not have metallization. The material of the lens holder plastic is 30% metal coated carbon. The lens barrel material is non-conductive carbon. The lens holder has a curved rib for attaching the module into the mobile phone. The connector is the spring type. The PWB material is FR4.

Pin assignment is shown in **Figure 9** and **Table 9.**

**Figure 5: Top view**

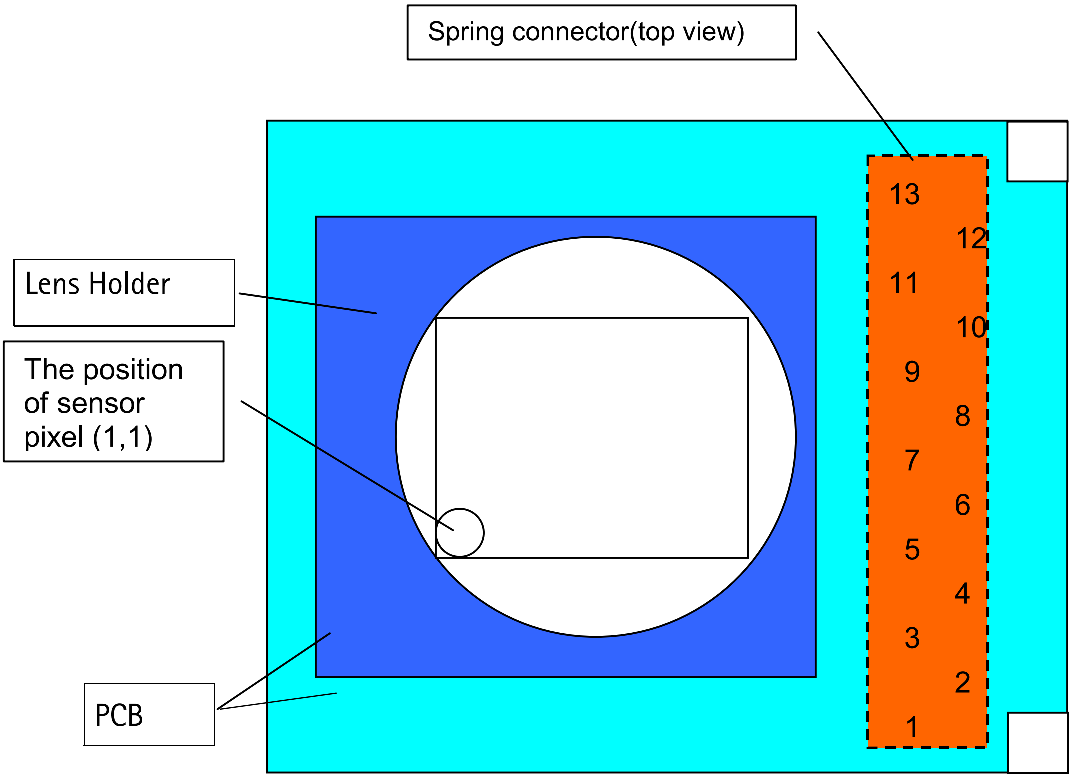



**Table 7: Pin assignment**

| **Pin number** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
|---|---|---|---|---|---|---|---|---|
| Pin name | VDD | GND2 | D+ | VDDI | D- | SDA | GND1 | SCL |
| Pin number | 9 | 10 | 11 | 12 | 13 | | | |
| Pin name | CLK+ | Vctrl | CLK- | GND3 | EXTCLK | | | |

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# Parts Lists

 

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## Table of Contents

# RF/System Module LG4 Parts List

0201707 LG4 RF/Syst Module EDMS Issue 13.6

**Table 1: 0201707 parts lis**

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| B190 | 4510303 | Top | Q | 8 | Crystal 32.768khz+-20ppm 12.5pf | Crystal_fc_255 |
| C100 | 2315203 | Top | M | 5 | Chip Array X5r 2x10n M 16v | 0405_2_P0.65_AVX |
| C101 | 2315203 | Top | P | 5 | Chip Array X5r 2x10n M 16v | 0405_2_P0.65_AVX |
| C102 | 2315203 | Top | M | 4 | Chip Array X5r 2x10n M 16v | 0405_2_P0.65_AVX |
| C104 | 2315203 | Top | P | 2 | Chip Array X5r 2x10n M 16v | 0405_2_P0.65_AVX |
| C105 | 2315203 | Top | M | 2 | Chip Array X5r 2x10n M 16v | 0405_2_P0.65_AVX |
| C106 | 2315203 | Top | M | 3 | Chip Array X5r 2x10n M 16v | 0405_2_P0.65_AVX |
| C132 | 2312255 | Top | P | 9 | Chip cap X5r 10u K 10v | 1206C |
| C133 | 2312249 | Top | Q | 9 | Chip cap X5r 4u7 K 10v | 0805C |
| C134 | 2320491 | Top | M | 9 | Chip cap X7r 220n K 10v | 0603C |
| C135 | 2312255 | Top | M | 9 | Chip cap X5RChip cap 10u K 10v | 1206C |
| C136 | 2320544 | Top | C | 10 | Chip cap 5% NP0 | 0402C |
| C137 | 2320544 | Top | Q | 10 | Chip cap 5% NP0 | 0402C |
| C171 | 2320560 | Top | L | 4 | Chip cap 5% NP0 | 0402C |
| C172 | 2320560 | Top | M | 5 | Chip cap 5% NP0 | 0402C |
| C173 | 2320560 | Top | M | 5 | Chip cap 5% NP0 | 0402C |
| C190 | 2320778 | Top | O | 8 | Chip cap X7R 10% 16V | 0402C |
| C191 | 2320481 | Top | O | 8 | Chip cap X5R 1u K 6v3 | 0603C |
| C193 | 2320481 | Top | P | 8 | Chip cap X5R 1u K 6v3 | 0603C |
| C194 | 2320481 | Top | M | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C195 | 2320805 | Top | N | 7 | Chip cap X5R 100N K 10V | 0402C |
| C197 | 2320481 | Top | P | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C198 | 2320481 | Top | O | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C199 | 2320481 | Top | Q | 5 | Chip cap X5R 1U K 6V3 | 0603C |
| C200 | 2320536 | Top | Q | 8 | Chip cap 5% NP0 | 0402C |
| C201 | 2320536 | Top | Q | 8 | Chip cap 5% NP0 | 0402C |
| C202 | 2320481 | Top | P | 8 | Chip cap X5R 1U K 6V3 | 0603C |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| C203 | 2320481 | Top | P | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C204 | 2320481 | Top | P | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C205 | 2320481 | Top | Q | 7 | Chip cap X5R 1U K 6V3 | 0603C |
| C206 | 2320481 | Top | Q | 7 | Chip cap X5R 1U K 6V3 | 0603C |
| C207 | 2320481 | Top | Q | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C208 | 2320481 | Top | Q | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C213 | 2320546 | Top | Q | 6 | Chip cap 5% NP0 | 0402C |
| C214 | 2320546 | Top | Q | 7 | Chip cap 5% NP0 | 0402C |
| C215 | 2320546 | Top | Q | 7 | Chip cap 5% NP0 | 0402C |
| C216 | 2320546 | Top | Q | 6 | Chip cap 5% NP0 | 0402C |
| C217 | 2320546 | Top | Q | 7 | Chip cap 5% NP0 | 0402C |
| C218 | 2320546 | Top | Q | 7 | Chip cap 5% NP0 | 0402C |
| C219 | 2320805 | Top | P | 5 | Chip cap X5R 100N K 10V | 0402C |
| C221 | 2320481 | Top | Q | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C222 | 2320481 | Top | N | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C223 | 2320481 | Top | N | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C224 | 2320481 | Top | N | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C225 | 2320744 | Top | Q | 5 | Chip cap X7R 10% 50V | 0402C |
| C226 | 2320481 | Top | N | 5 | Chip cap X5R 1U K 6V3 | 0603C |
| C227 | 2320481 | Top | M | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C228 | 2320481 | Top | M | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C229 | 2320481 | Top | M | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C230 | 2320481 | Top | M | 7 | Chip cap X5R 1U K 6V3 | 0603C |
| C231 | 2320481 | Top | N | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C232 | 2320481 | Top | N | 7 | Chip cap X5R 1U K 6V3 | 0603C |
| C233 | 2320481 | Top | M | 6 | Chip cap X5R 1U K 6V3 | 0603C |
| C234 | 2320481 | Top | N | 7 | Chip cap X5R 1U K 6V3 | 0603C |
| C235 | 2320481 | Top | N | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C236 | 2320481 | Top | N | 7 | Chip cap X5R 1U K 6V3 | 0603C |
| C237 | 2320805 | Top | M | 6 | Chip cap X5R 100N K 10V | 0402C |
| C238 | 2315263 | Top | N | 8 | Chip cap | 0405_2_P0.65_AVX |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| C239 | 2315205 | Top | Q | 6 | Chip cap | 0405_2_P0.65_AVX |
| C240 | 2315205 | Top | Q | 6 | Chip cap | 0405_2_P0.65_AVX |
| C241 | 2320805 | Top | P | 5 | Chip cap X5R 100N K 10V | 0402C |
| C242 | 2320805 | Top | M | 6 | Chip cap X5R 100N K 10V | 0402C |
| C260 | 2613009 | Top | T | 7 | Chip cap | TANT_TPSY |
| C261 | 2320778 | Top | R | 7 | Chip cap X7R 10% 16V | 0402C |
| C262 | 2310793 | Top | R | 7 | Chip cap X5R 2U2 K 10V | 0805C |
| C266 | 2310793 | Top | S | 5 | Chip cap X5R 2U2 K 10V | 0805C |
| C268 | 2310793 | Top | R | 7 | Chip cap X5R 2U2 K 10V | 0805C |
| C270 | 2310793 | Top | S | 5 | Chip cap X5R 2U2 K 10V | 0805C |
| C271 | 2320137 | Top | R | 6 | Chip cap X5R 470N K 10V | 0603C |
| C272 | 2320137 | Top | R | 6 | Chip cap X5R 470N K 10V | 0603C |
| C273 | 2320568 | Top | T | 5 | Chip cap 5% X7R | 0402C |
| C274 | 2320568 | Top | T | 5 | Chip cap 5% X7R | 0402C |
| C275 | 2320805 | Top | T | 5 | Chip cap X5R 100N K 10V | 0402C |
| C276 | 2312401 | Top | T | 5 | Chip cap X5R 1U0 10V | 0805C |
| C277 | 2320778 | Top | T | 5 | Chip cap X7R 10% 16V | 0402C |
| C278 | 2320744 | Top | T | 5 | Chip cap X7R 10% 50V | 0402C |
| C279 | 2312255 | Top | R | 6 | Chip cap X5R 10U K 10V 1206 | 1206C |
| C280 | 2320544 | Top | R | 6 | Chip cap 5% NP0 | 0402C |
| C281 | 2320544 | Top | R | 6 | Chip cap 5% NP0 | 0402C |
| C282 | 2320481 | Top | S | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C283 | 2320481 | Top | S | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C284 | 2320481 | Top | R | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C285 | 2320481 | Top | S | 8 | Chip cap X5R 1U K 6V3 | 0603C |
| C287 | 2320778 | Top | R | 7 | Chip cap X7R 10% 16V | 0402C |
| C300 | 2312401 | Top | N | 8 | Chip cap X5R 1U0 10V | 0805C |
| C301 | 2312401 | Top | M | 7 | Chip cap X5R 1U0 10V | 0805C |
| C302 | 2312255 | Top | M | 8 | Chip cap X5R 10U K 10V 1206 | 1206C |
| C303 | 2312255 | Top | T | 8 | Chip cap X5R 10U K 10V 1206 | 1206C |
| C304 | 2320805 | Top | T | 8 | Chip cap X5R 100N K 10V | 0402C |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| C305 | 2610041 | Top | R | 5 | Chip cap | TANT_TPSY |
| C306 | 2610041 | Top | U | 5 | Chip cap | TANT_TPSY |
| C307 | 2320744 | Top | T | 8 | Chip cap X7R 10% 50V | 0402C |
| C308 | 2320778 | Top | S | 5 | Chip cap X7R 10% 16V | 0402C |
| C309 | 2320560 | Top | T | 5 | Chip cap 5% NP0 | 0402C |
| C311 | 2315263 | Top | Q | 4 | Chip cap | 0405_2_P0.65_AVX |
| C312 | 2320779 | Top | S | 4 | Chip cap X7R 100N K 16V | 0603_BLM |
| C313 | 2315263 | Top | S | 4 | Chip cap | 0405_2_P0.65_AVX |
| C314 | 2320778 | Top | M | 1 | Chip cap X7R 10% 16V | 0402C |
| C315 | 2320778 | Top | P | 1 | Chip cap X7R 10% 16V | 0402C |
| C316 | 2315203 | Top | P | 2 | Chip cap | 0405_2_P0.65_AVX |
| C317 | 2315203 | Top | P | 2 | Chip cap | 0405_2_P0.65_AVX |
| C318 | 2320805 | Top | M | 2 | Chip cap X5R 100N K 10V | 0402C |
| C330 | 2320783 | Top | T | 4 | Chip cap X7R 33N K 10V | 0402C |
| C331 | 2320783 | Top | T | 4 | Chip cap X7R 33N K 10V | 0402C |
| C332 | 2320544 | Top | U | 4 | Chip cap 5% NP0 | 0402C |
| C333 | 2312243 | Top | T | 4 | Chip cap X5R 4U7 K 6V3 | 0805C |
| C334 | 2320544 | Top | T | 4 | Chip cap 5% NP0 | 0402C |
| C336 | 2320544 | Top | D | 4 | Chip cap 5% NP0 | 0402C |
| C337 | 2320544 | Top | D | 4 | Chip cap 5% NP0 | 0402C |
| C338 | 2320544 | Top | D | 4 | Chip cap 5% NP0 | 0402C |
| C339 | 2320544 | Top | E | 6 | Chip cap 5% NP0 | 0402C |
| C340 | 2320544 | Top | E | 7 | Chip cap 5% NP0 | 0402C |
| C341 | 2320544 | Top | E | 7 | Chip cap 5% NP0 | 0402C |
| C342 | 2320744 | Top | E | 4 | Chip cap X7R 10% 50V | 0402C |
| C343 | 2320744 | Top | E | 4 | Chip cap X7R 10% 50V | 0402C |
| C344 | 2320783 | Top | E | 3 | Chip cap X7R 33N K 10V | 0402C |
| C345 | 2320783 | Top | E | 3 | Chip cap X7R 33N K 10V | 0402C |
| C346 | 2320544 | Top | D | 3 | Chip cap 5% NP0 | 0402C |
| C347 | 2320744 | Top | E | 3 | Chip cap X7R 10% 50V | 0402C |
| C348 | 2320744 | Top | E | 3 | Chip cap X7R 10% 50V | 0402C |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| C349 | 2320560 | Top | E | 4 | Chip cap 5% NP0 | 0402C |
| C350 | 2320544 | Top | E | 4 | Chip cap 5% NP0 | 0402C |
| C353 | 2320778 | Top | E | 4 | Chip cap X7R 10% 16V | 0402C |
| C354 | 2312243 | Top | C | 1 | Chip cap X5R 4U7 K 6V3 | 0805C |
| C355 | 2320778 | Top | E | 3 | Chip cap X7R 10% 16V | 0402C |
| C356 | 2320778 | Top | E | 3 | Chip cap X7R 10% 16V | 0402C |
| C357 | 2320778 | Top | E | 3 | Chip cap X7R 10% 16V | 0402C |
| C360 | 2320805 | Top | E | 5 | Chip cap X5R 100N K 10V | 0402C |
| C361 | 2312255 | Top | E | 5 | Chip cap X5R 10U K 10V 1206 | 1206C |
| C362 | 2320544 | Top | E | 4 | Chip cap 5% NP0 | 0402C |
| C363 | 2320137 | Top | E | 4 | Chip cap X5R 470N K 10V | 0603C |
| C380 | 2611745 | Top | U | 7 | Chip cap | TANT_TPSY |
| C381 | 2320805 | Top | M | 2 | Chip cap X5R 100N K 10V | 0402C |
| C382 | 2320536 | Top | L | 2 | Chip cap 5% NP0 | 0402C |
| C383 | 2320544 | Top | U | 6 | Chip cap 5% NP0 | 0402C |
| C430 | 2320805 | Top | L | 2 | Chip cap X5R 100N K 10V | 0402C |
| C431 | 2320481 | Top | E | 4 | Chip cap X5R 1U K 6V3 | 0603C |
| C450 | 2320544 | Top | M | 4 | Chip cap 5% NP0 | 0402C |
| C451 | 2320544 | Top | L | 4 | Chip cap 5% NP0 | 0402C |
| C452 | 2320544 | Top | M | 4 | Chip cap 5% NP0 | 0402C |
| C470 | 2320805 | Top | D | 6 | Chip cap X5R 100N K 10V | 0402C |
| C501 | 2320548 | Top | G | 7 | Chip cap 5% NP0 | 0402C |
| C502 | 2320536 | Top | H | 5 | Chip cap 5% NP0 | 0402C |
| C503 | 2320546 | Top | H | 8 | Chip cap 5% NP0 | 0402C |
| C510 | 2320481 | Top | K | 9 | Chip cap X5R 1U K 6V3 | 0603C |
| C511 | 2320481 | Top | K | 10 | Chip cap X5R 1U K 6V3 | 0603C |
| C512 | 2320481 | Top | K | 10 | Chip cap X5R 1U K 6V3 | 0603C |
| C513 | 2320481 | Top | K | 9 | Chip cap X5R 1U K 6V3 | 0603C |
| C522 | 2315019 | Top | J | 10 | Chip cap | 0612_H0.94 |
| C530 | 2320562 | Top | K | 10 | Chip cap 5% NP0 | 0402C |
| C531 | 2320562 | Top | K | 9 | Chip cap 5% NP0 | 0402C |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| C532 | 2320783 | Top | K | 10 | Chip cap X7R 33N K 10V | 0402C |
| C533 | 2320783 | Top | K | 9 | Chip cap X7R 33N K 10V | 0402C |
| C534 | 2320778 | Top | K | 7 | Chip cap X7R 10% 16V | 0402C |
| C535 | 2320805 | Top | J | 7 | Chip cap X5R 100N K 10V | 0402C |
| C540 | 2320552 | Top | J | 7 | Chip cap 5% NP0 | 0402C |
| C541 | 2320552 | Top | K | 7 | Chip cap 5% NP0 | 0402C |
| C550 | 2320778 | Top | J | 7 | Chip cap X7R 10% 16V | 0402C |
| C551 | 2320536 | Top | J | 7 | Chip cap 5% NP0 | 0402C |
| C557 | 2320554 | Top | I | 10 | Chip cap 5% NP0 | 0402C |
| C558 | 2320778 | Top | J | 8 | Chip cap X7R 10% 16V | 0402C |
| C560 | 2320548 | Top | K | 9 | Chip cap 5% NP0 | 0402C |
| C561 | 2320620 | Top | J | 7 | Chip cap X7R 5% 16V | 0402C |
| C562 | 2320805 | Top | J | 9 | Chip cap X5R 100N K 10V | 0402C |
| C581 | 2320633 | Top | L | 7 | Chip cap NP0 220P J 25V | 0402C |
| C582 | 2318011 | Top | K | 8 | Chip cap | 0805C_H1.35 |
| C583 | 2320564 | Top | L | 7 | Chip cap 5% NP0 | 0402C |
| C584 | 2320520 | Top | L | 9 | Chip cap +-0.25pF NP0 | 0402C |
| C586 | 2320554 | Top | L | 9 | Chip cap 5% NP0 | 0402C |
| C591 | 2320560 | Top | K | 7 | Chip cap 5% NP0 | 0402C |
| C592 | 2320779 | Top | L | 6 | Chip cap X7R 100N K 16V | 0603_BLM |
| C593 | 2320560 | Top | K | 7 | Chip cap 5% NP0 | 0402C |
| C594 | 2320560 | Top | K | 6 | Chip cap 5% NP0 | 0402C |
| C595 | 2320560 | Top | K | 5 | Chip cap 5% NP0 | 0402C |
| C596 | 2320481 | Top | K | 9 | Chip cap X5R 1U K 6V3 | 0603C |
| C597 | 2320546 | Top | F | 9 | Chip cap 5% NP0 | 0402C |
| C599 | 2320560 | Top | I | 9 | Chip cap 5% NP0 | 0402C |
| C601 | 2320560 | Top | I | 10 | Chip cap 5% NP0 | 0402C |
| C610 | 2320526 | Top | G | 9 | Chip cap +-0.25pF NP0 | 0402C |
| C612 | 2320491 | Top | G | 10 | Chip cap X7R 220N K 10V | 0603C |
| C613 | 2320546 | Top | G | 9 | Chip cap 5% NP0 | 0402C |
| C614 | 2320778 | Top | F | 10 | Chip cap X7R 10% 16V | 0402C |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| C630 | 2320560 | Top | I | 9 | Chip cap 5% NP0 | 0402C |
| C631 | 2320560 | Top | I | 9 | Chip cap 5% NP0 | 0402C |
| C632 | 2320560 | Top | G | 9 | Chip cap 5% NP0 | 0402C |
| C640 | 2320508 | Top | G | 9 | Chip cap +-0.25pF NP0 | 0402C |
| C641 | 2320536 | Top | G | 9 | Chip cap 5% NP0 | 0402C |
| C642 | 2320805 | Top | G | 8 | Chip cap X5R 100N K 10V | 0402C |
| C643 | 2320552 | Top | G | 8 | Chip cap 5% NP0 | 0402C |
| C662 | 2320536 | Top | L | 6 | Chip cap 5% NP0 | 0402C |
| C670 | 2320548 | Top | E | 9 | Chip cap 5% NP0 | 0402C |
| C671 | 2320548 | Top | G | 8 | Chip cap 5% NP0 | 0402C |
| C711 | 2320540 | Top | G | 5 | Chip cap 5% NP0 | 0402C |
| C712 | 2320778 | Top | F | 5 | Chip cap X7R 10% 16V | 0402C |
| C713 | 2320778 | Top | I | 5 | Chip cap X7R 10% 16V | 0402C |
| C714 | 2320546 | Top | I | 5 | Chip cap 5% NP0 | 0402C |
| C715 | 2320548 | Top | I | 6 | Chip cap 5% NP0 | 0402C |
| C720 | 2320778 | Top | H | 5 | Chip cap X7R 10% 16V | 0402C |
| C722 | 2320778 | Top | F | 5 | Chip cap X7R 10% 16V | 0402C |
| C731 | 2320546 | Top | F | 7 | Chip cap 5% NP0 | 0402C |
| C733 | 2320548 | Top | E | 8 | Chip cap 5% NP0 | 0402C |
| C751 | 2320620 | Top | H | 5 | Chip cap X7R 5% 16V | 0402C |
| C755 | 2320778 | Top | I | 7 | Chip cap X7R 10% 16V | 0402C |
| C757 | 2320778 | Top | G | 7 | Chip cap X7R 10% 16V | 0402C |
| C760 | 2320546 | Top | F | 6 | Chip cap 5% NP0 | 0402C |
| C761 | 2320538 | Top | F | 7 | Chip cap 5% NP0 | 0402C |
| C762 | 2320538 | Top | F | 6 | Chip cap 5% NP0 | 0402C |
| C763 | 2320536 | Top | G | 7 | Chip cap 5% NP0 | 0402C |
| C765 | 2320548 | Top | F | 5 | Chip cap 5% NP0 | 0402C |
| C772 | 2312243 | Top | I | 6 | Chip cap X5R 4U7 K 6V3 | 0805C |
| C782 | 2611753 | Top | J | 5 | Chip cap | TANT_TPSW2 |
| C800 | 2320548 | Top | J | 7 | Chip cap 5% NP0 | 0402C |
| C802 | 2322023 | Top | G | 8 | Chip cap NP0 2N2 J 16V | 0603C |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| C803 | 2320560 | Top | H | 8 | Chip cap 5% NP0 | 0402C |
| C804 | 2320558 | Top | J | 6 | Chip cap 5% NP0 | 0402C |
| C805 | 2320548 | Top | I | 7 | Chip cap 5% NP0 | 0402C |
| C806 | 2320584 | Top | J | 8 | Chip cap 5% X7R | 0402C |
| C813 | 2320548 | Top | H | 7 | Chip cap 5% NP0 | 0402C |
| C820 | 2320554 | Top | J | 7 | Chip cap 5% NP0 | 0402C |
| C831 | 2320604 | Top | H | 7 | Chip cap 5% NP0 | 0402C |
| C832 | 2320629 | Top | I | 8 | Chip cap NP0 1P0 B 50V | 0402C |
| C833 | 2320514 | Top | H | 8 | Chip cap +-0.25pF NP0 | 0402C |
| C834 | 2320514 | Top | H | 8 | Chip cap +-0.25pF NP0 | 0402C |
| D100 | 4370871 | Top | N | 4 | UPP_WD2-V2.2 F741973 | CSP_240 |
| D190 | 4370841 | Top | O | 6 | UEM V6.0 W-DOG ENA TO09 | uBGA168 |
| D310 | 4340831 | Top | Q | 3 | IC | uBGA40_P0.5_10.0 X7.0 |
| D311 | 4341343 | Top | S | 3 | IC | uBGA40_WC128_1 2.6X12.1 |
| D312 | 4341341 | Top | N | 2 | IC | uBGA52_H1.1 |
| G190 | 4700129 | Top | L | 3 | Batt | ML414R_TT30 |
| G591 | 4510349 | Top | L | 7 | VCTCXO_ | KT20 |
| G650 | 4350243 | Top | L | 8 | VCO_GK | _601MNA_2 |
| L130 | 3203723 | Top | Q | 10 | Ferrite | BK1608 |
| L131 | 3640123 | Top | N | 9 | DO1605T | 103 |
| L132 | 3203723 | Top | M | 10 | Ferrite | BK1608 |
| L260 | 3640117 | Top | U | 8 | NP05DB220M | NP05DB220M |
| L300 | 3203701 | Top | T | 8 | Ferrite | 0805 |
| L301 | 3203801 | Top | D | 4 | Coil | 0405_2_MATSU |
| L302 | 3203801 | Top | D | 3 | Coil | 0405_2_MATSU |
| L430 | 3203701 | Top | E | 4 | Ferrite | 0805 |
| L431 | 3203701 | Top | E | 2 | Ferrite | 0805 |
| L432 | 3646083 | Top | E | 5 | Chip coil 100N J Q16/300M | 0402L |
| L566 | 3646085 | Top | E | 9 | Chip coil 6N8 K Q29/800M | 0402L |
| L567 | 3646065 | Top | F | 9 | Chip coil 12N J Q31/800M | 0402L |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| L600 | 3646067 | Top | I | 9 | Chip coil 18N J Q29/800M | 0402L |
| L610 | 3646013 | Top | F | 10 | Coil | 0402_ELJRF |
| L630 | 3646091 | Top | I | 9 | Chip coil 6N8 J Q27/800M | 0402L |
| L640 | 3646051 | Top | G | 8 | Chip coil 3N9 +-0N3 Q28/800M | 0402L |
| L672 | 3646007 | Top | E | 8 | Chip coil 27N J Q27/800M | 0402L |
| L704 | 3646039 | Top | F | 5 | Coil | 0402_ELJRF |
| L705 | 3645065 | Top | F | 6 | Chip coil 5N6 K Q98/1.5GHZ | 0805HQ |
| L708 | 3203715 | Top | F | 5 | Ferrite | Ferrite_BK1005 |
| L749 | 4551015 | Top | G | 7 | COUPLER | COUPLER_LDC15D |
| L751 | 3203705 | Top | I | 5 | Ferrite | 0805_ Ferrite |
| L820 | 3646015 | Top | I | 7 | ELJRF | 0402_ELJRF |
| L821 | 3646015 | Top | J | 7 | ELJRF | 0402_ELJRF |
| L830 | 3646051 | Top | I | 8 | Chip coil 3N9 +-0N3 Q28/800M | 0402L |
| N130 | 4341353 | Top | O | 9 | CSP_8 | TEA1207UK DC/DC CONV 2.9-5.5V |
| N260 | 4370861 | Top | S | 6 | IC | uBGA80_H1.23 |
| N380 | 4341087 | Top | M | 2 | IC | TSOP_6_H1.1 |
| N430 | 4350289 | Top | I | 3 | IC | BT102_X_BLUETOO TH |
| N505 | 4370781 | Top | J | 8 | IC | uBGA80_H1.7 |
| N701 | 4350297 | Top | G | 6 | IC | RF_AMP_RF9203_E 5_H1.65 |
| R100 | 1430726 | Top | P | 5 | Resistor 5% 63mW | 0402R |
| R101 | 1430726 | Top | P | 5 | Resistor 5% 63mW | 0402R |
| R102 | 1430786 | Top | P | 5 | Resistor 5% 63mW | 0402R |
| R130 | 1430762 | Top | C | 10 | Resistor 5% 63mW | 0402R |
| R131 | 1430788 | Top | E | 10 | Resistor 5% 63mW | 0402R |
| R132 | 1820037 | Top | E | 10 | NTC RES 47K B=4050+-3% | 0603_BLM |
| R133 | 1430754 | Top | P | 4 | Resistor 5% 63mW | 0402R |
| R134 | 1430778 | Top | L | 4 | Resistor 5% 63mW | 0402R |
| R135 | 1430778 | Top | L | 4 | Resistor 5% 63mW | 0402R |
| R136 | 1430744 | Top | Q | 9 | Resistor 5% 63mW | 0402R |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| R137 | 1430861 | Top | Q | 9 | Resistor  0W06 110K F | 0402R |
| R138 | 1430794 | Top | Q | 9 | Resistor 5% 63mW | 0402R |
| R141 | 1430756 | Top | P | 4 | Resistor 5% 63mW | 0402R |
| R171 | 1430726 | Top | L | 4 | Resistor 5% 63mW | 0402R |
| R172 | 1430778 | Top | M | 5 | Resistor 5% 63mW | 0402R |
| R173 | 1430778 | Top | M | 5 | Resistor 5% 63mW | 0402R |
| R190 | 1419003 | Top | O | 8 | Resistor  0W5 0R22 J | 1210_R |
| R191 | 1430804 | Top | Q | 5 | Resistor 5% 63mW | 0402R |
| R192 | 1430812 | Top | M | 7 | Resistor 5% 63mW | 0402R |
| R193 | 1430804 | Top | Q | 5 | Resistor 5% 63mW | 0402R |
| R194 | 1430790 | Top | M | 5 | Resistor 5% 63mW | 0402R |
| R262 | 1430718 | Top | T | 5 | Resistor 5% 63mW | 0402R |
| R300 | 1413850 | Top | S | 5 | Resistor  0W125 4R7 J | 0805R |
| R301 | 1413850 | Top | S | 4 | Resistor  0W125 4R7 J | 0805R |
| R311 | 1430778 | Top | P | 4 | Resistor 5% 63mW | 0402R |
| R313 | 1430778 | Top | Q | 4 | Resistor 5% 63mW | 0402R |
| R314 | 1430770 | Top | P | 4 | Resistor 5% 63mW | 0402R |
| R330 | 1430137 | Top | U | 4 | Resistor 0W06 1K0 F 200PPM | 0402R |
| R331 | 1430137 | Top | U | 4 | Resistor  0W06 1K0 F 200PPM | 0402R |
| R332 | 1825033 | Top | U | 4 | Chip varistor VW14V VC46V | 0402_VAR |
| R333 | 1825033 | Top | U | 4 | Chip varistor VW14V VC46V | 0402_VAR |
| R334 | 1825033 | Top | D | 4 | Chip varistor VW14V VC46V | 0402_VAR |
| R335 | 1825033 | Top | D | 4 | Chip varistor VW14V VC46V | 0402_VAR |
| R336 | 1825033 | Top | E | 6 | Chip varistor VW14V VC46V | 0402_VAR |
| R337 | 1825033 | Top | E | 7 | Chip varistor VW14V VC46V | 0402_VAR |
| R338 | 1430137 | Top | E | 3 | Resistor 0W06 1K0 F 200PPM | 0402R |
| R339 | 1430762 | Top | E | 3 | Resistor 5% 63mW | 0402R |
| R340 | 1430762 | Top | E | 3 | Resistor 5% 63mW | 0402R |
| R341 | 1430137 | Top | E | 2 | Resistor0W06 1K0 F 200PPM | 0402R |
| R342 | 1825033 | Top | D | 4 | Chip varistor VW14V VC46V | 0402_VAR |
| R343 | 1825033 | Top | D | 4 | Chip varistor VW14V VC46V | 0402_VAR |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| R344 | 1825033 | Top | E | 3 | Chip varistor VW14V VC46V | 0402_VAR |
| R345 | 1825033 | Top | E | 3 | Chip varistor VW14V VC46V | 0402_VAR |
| R346 | 1825033 | Top | D | 3 | Chip varistor VW14V VC46V | 0402_VAR |
| R347 | 1430681 | Top | S | 5 | Resistor 0W06 4R3 J | 0402R |
| R348 | 1430137 | Top | E | 3 | Resistor 0W06 1K0 F 200PPM | 0402R |
| R349 | 1620103 | Top | E | 4 | Resistor | 0404_R_SR |
| R350 | 1430718 | Top | E | 3 | Resistor 5% 63mW | 0402R |
| R352 | 1430718 | Top | E | 3 | Resistor 5% 63mW | 0402R |
| R353 | 1430734 | Top | T | 4 | Resistor 5% 63mW | 0402R |
| R360 | 1430693 | Top | E | 4 | Chipres 0W06 5R6 J | 0402R |
| R361 | 1430693 | Top | E | 4 | Chipres 0W06 5R6 J | 0402R |
| R362 | 1430693 | Top | E | 5 | Chipres 0W06 5R6 J | 0402R |
| R363 | 1430693 | Top | E | 5 | Chipres 0W06 5R6 J | 0402R |
| R380 | 1825033 | Top | U | 5 | Chip varistor VW14V VC46V | 0402_VAR |
| R382 | 1825033 | Top | U | 5 | Chip varistor VW14V VC46V | 0402_VAR |
| R383 | 1430804 | Top | T | 9 | Resistor 5% 63mW | 0402R |
| R384 | 1430804 | Top | T | 9 | Resistor 5% 63mW | 0402R |
| R470 | 4120071 | Top | E | 6 | ASIP EMIF03-SIM01 SIM FILTER | uBGA8 |
| R471 | 1430786 | Top | E | 6 | Resistor 5% 63mW | 0402R |
| R510 | 1620081 | Top | K | 9 | Res. network 0W03 4X22R J 0804 | MNR04 |
| R532 | 1430846 | Top | I | 8 | Resistor 1% 63mW | 0402R |
| R533 | 1430770 | Top | K | 7 | Resistor 5% 63mW | 0402R |
| R534 | 1430770 | Top | J | 7 | Resistor 5% 63mW | 0402R |
| R541 | 1620033 | Top | K | 6 | Res. network 0W06 2X5K6 J | 0404_R |
| R550 | 1620033 | Top | J | 6 | Res. network 0W06 2X5K6 J | 0404_R |
| R551 | 1430700 | Top | J | 7 | Resistor 5% 63mW | 0402R |
| R580 | 1430865 | Top | K | 7 | Resistor 0W06 5K6 F | 0402R |
| R581 | 1430841 | Top | L | 7 | Resistor 0W06 6k8 F | 0402R |
| R582 | 1430700 | Top | L | 9 | Resistor 5% 63mW | 0402R |
| R591 | 1430778 | Top | K | 6 | Resistor 5% 63mW | 0402R |
| R592 | 1430774 | Top | L | 6 | Resistor 5% 63mW | 0402R |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| R593 | 1430746 | Top | K | 5 | Resistor 5% 63mW | 0402R |
| R594 | 1430712 | Top | L | 5 | Resistor 5% 63mW | 0402R |
| R595 | 1430734 | Top | K | 5 | Resistor 5% 63mW | 0402R |
| R596 | 1430762 | Top | K | 7 | Resistor 5% 63mW | 0402R |
| R610 | 1430726 | Top | G | 10 | Resistor 5% 63mW | 0402R |
| R612 | 1430700 | Top | G | 10 | Resistor 5% 63mW | 0402R |
| R616 | 1430832 | Top | F | 10 | Resistor 5% 63mW | 0402R |
| R642 | 1430700 | Top | G | 8 | Resistor 5% 63mW | 0402R |
| R643 | 1430740 | Top | G | 8 | Resistor 5% 63mW | 0402R |
| R646 | 1430832 | Top | G | 9 | Resistor 5% 63mW | 0402R |
| R670 | 1430700 | Top | E | 8 | Resistor 5% 63mW | 0402R |
| R730 | 1430718 | Top | G | 7 | Resistor 5% 63mW | 0402R |
| R745 | 1430714 | Top | I | 7 | Resistor 5% 63mW | 0402R |
| R746 | 1430718 | Top | I | 8 | Resistor 5% 63mW | 0402R |
| R747 | 1430734 | Top | G | 7 | Resistor 5% 63mW | 0402R |
| R763 | 1430726 | Top | F | 6 | Resistor 5% 63mW | 0402R |
| R764 | 1430770 | Top | F | 7 | Resistor 5% 63mW | 0402R |
| R800 | 1430770 | Top | G | 7 | Resistor 5% 63mW | 0402R |
| R801 | 1430788 | Top | H | 8 | Resistor 5% 63mW | 0402R |
| R802 | 1430784 | Top | J | 6 | Resistor 5% 63mW | 0402R |
| R803 | 1430778 | Top | G | 8 | Resistor 5% 63mW | 0402R |
| R804 | 1430770 | Top | H | 8 | Resistor 5% 63mW | 0402R |
| R820 | 1620121 | Top | J | 7 | Res. network 0W06 2X220R J | MNR02_SR0404 |
| R821 | 1620515 | Top | J | 6 | Resistor | 0404_RAC10 |
| R822 | 1430693 | Top | I | 7 | Chipres 0W06 5R6 J | 0402R |
| R823 | 1430693 | Top | J | 7 | Chipres 0W06 5R6 J | 0402R |
| R830 | 1620121 | Top | H | 8 | Res. network 0W06 2X220R J | MNR02_SR |
| R831 | 1620515 | Top | I | 7 | Resistor | 0404_RAC10 |
| S130 | 520D001 | Top | C | 10 | AGK_3233 | 42VDC 100MA |
| T580 | 3640423 | Top | K | 8 | Transistor | LDB15 |
| T830 | 4550137 | Top | H | 8 | Transistor | LDB15 |

| Item | Code | Side | X | Y | Component Name | Type, vaue |
|---|---|---|---|---|---|---|
| V130 | 4864901 | Top | D | 9 | TR PHOTO SFH3410 | SFH2400 |
| V132 | 4110451 | Top | P | 10 | SCH DI MBRM120L 20V 1A | DO_216AA |
| V334 | 4860009 | Top | C | 2 | LED | LED_CL200 |
| V335 | 4864911 | Top | D | 2 | DI PHOTO 950NM 20NS | BPW34 |
| V360 | 4860101 | Top | B | 5 | IRDA 9.K6-1M152 | TFDU5102 |
| V590 | 4210066 | Top | K | 5 | Tr NPN 12V 35mA SOT323 | SOT323 |
| V610 | 4210277 | Top | F | 9 | TR BGB420 | SOT343_R |
| V640 | 4210261 | Top | G | 9 | TR BGA428 LNA1.8GHZ 19.5DB | SOT_363 |
| V760 | 4110079 | Top | F | 7 | SCH DIX2 HSMS282C 15V <1PF | SOT323 |
| X130 | 5469167 | Top | S | 10 | Conn | DF12B_2X15F |
| X330 | 5409119 | Top | B | 3 | Jack | T_285332 |
| X331 | 5409227 | Top | C | 5 | Earpiece Adapter | DMD07692 |
| X380 | 9855053 | Bot-tom | V | 6 | FLEX L4 75.2X31.7 S | FPC_2400 |
| Z130 | 4120035 | Top | S | 8 | ASIP EMI/ESD10CH | IP4041CX25 BGA25 |
| Z131 | 4120035 | Top | R | 8 | ASIP EMI/ESD10CH | IP4041CX25 BGA25 |
| Z300 | 3640011 | Top | N | 8 | EMI FILT Z>600R/100M OR6MAX 0.2A | 0805_BLM |
| Z301 | 3640011 | Top | M | 7 | EMI FILT Z>600R/100M OR6MAX 0.2A | 0805_BLM |
| Z302 | 3203751 | Top | M | 8 | Ferrite | FBMH |
| Z330 | 3203725 | Top | D | 4 | Ferrite | 0402 |
| Z331 | 3203725 | Top | D | 4 | Ferrite | 0402 |
| Z332 | 3203725 | Top | D | 3 | Ferrite_ | 0402 |
| Z333 | 3203725 | Top | D | 3 | Ferrite | 0402 |
| Z383 | 4120035 | Top | T | 8 | ASIP EMI/ESD10CH | IP4041CX25 BGA25 |
| Z384 | 4120035 | Top | U | 5 | ASIP EMI/ESD10CH | IP4041CX25 BGA25 |
| Z600 | 4511235 | Top | H | 9 | DCC6D | H1.15 |
| Z672 | 4550205 | Top | F | 8 | ANT_SW | LMZ0135_6A3 |
| Z800 | 4511237 | Top | J | 6 | DCC6D | H1.15 |
| Z802 | 4511241 | Top | H | 9 | DCC6D | H1.15 |

# Grip Module LS4 Parts List

0201711 LS4 RF/Syst Module EDMS Issue: 6.0

**Table 2: 0201711 parts list**

| Item | Code | Part name | Part value |
|---|---|---|---|
| R006 | 1825033 | Chip varistor vwm14v vc4 | VC4 |
| R007 | 1825033 | Chip varistor vwm14v vc4 | VC4 |
| R008 | 1825033 | Chip varistor vwm14v vc4 | VC4 |
| R011 | 1430754 | chipres 0w06 1k0 j | |
| R012 | 1430804 | chipres 0w06 100k j | |
| R013 | 1430427 | chipres 0w06 37r4 f 100p | 100P |
| R014 | 1430427 | chipres 0w06 37r4 f 100p | 100P |
| C002 | 2320546 | Chip cap np0 27p j 50v | |
| C003 | 2310793 | Chip cap x5r 2u2 k 10v | |
| C004 | 2320783 | Chip cap x7r 33n k 10v | |
| C005 | 2320546 | Chip cap np0 27p j 50v | |
| C006 | 2312203 | Chip cap y5v 1u z 50v | |
| C007 | 2320805 | Chip cap x5r 100n k 10v | |
| C008 | 2320805 | Chip cap x5r 100n k 10v | |
| C010 | 2320546 | Chip cap np0 27p j 50v | |
| C011 | 2320744 | Chip cap x7r 1n0 k 50v | |
| C012 | 2360001 | Chip cap x5r 330n k 10v | |
| C013 | 2312243 | Chip cap x5r 4u7 k 6v3 | |
| C014 | 2360001 | Chip cap x5r 330n k 10v | |
| C015 | 2320481 | Chip cap x5r 1u k 6v3 | |
| C018 | 2310037 | Chip cap x5r 10u m 6v3 | |
| L001 | 3203701 | Ferrite bead 33r/100mhz | 33R/100MHZ |
| F001 | 5119019 | sm fuse f 1.5a 32v | 0603 |
| V001 | 4860331 | led lwl88s white >3,4v i | I |
| V002 | 4860331 | led lwl88s white >3,4v i | I |
| V003 | 4860331 | led lwl88s white >3,4v i | I |
| V004 | 4860331 | led lwl88s white >3,4v i | I |
| V005 | 4860331 | led lwl88s white >3,4v i | I |
| V006 | 4860331 | led lwl88s white >3,4v i | I |

| Item | Code | Part name | Part value |
|---|---|---|---|
| V009 | 4113721 | tvs di 1pmt16at3 16v 175 | 175 |
| V012 | 4110089 | dix2 bav70w cc 70v .5a 4 | 4 |
| V013 | 4860331 | led lwl88s white >3,4v i | I |
| V014 | 4860331 | led lwl88s white >3,4v i | I |
| V016 | 4110089 | dix2 bav70w cc 70v .5a 4 | 4 |
| N001 | 4341165 | current sense(lm3822mmx- | SENSE(LM3822MMX- |
| N320 | 4341137 | dc/dc conv 4.1v/80ma(lm3 | 4.1V/80MA(LM3 |
| X001 | 5460059 | sm conn 2x25m p0.5 50v.5 | 50V.5 |
| X004 | 5400247 | sm conn vibra spacer pad | PAD |
| X005 | 5400247 | sm conn vibra spacer pad | PAD |
| X006 | 5400245 | sm conn dc-jack spacer p | P |
| X007 | 5400245 | sm conn dc-jack spacer p | P |
| X008 | 5400245 | sm conn dc-jack spacer p | P |
| I052 | 9854561 | pwb ls4_18 60.0x45.6x0.6 | 60.0x45.6x0.6 |

# Product Variants

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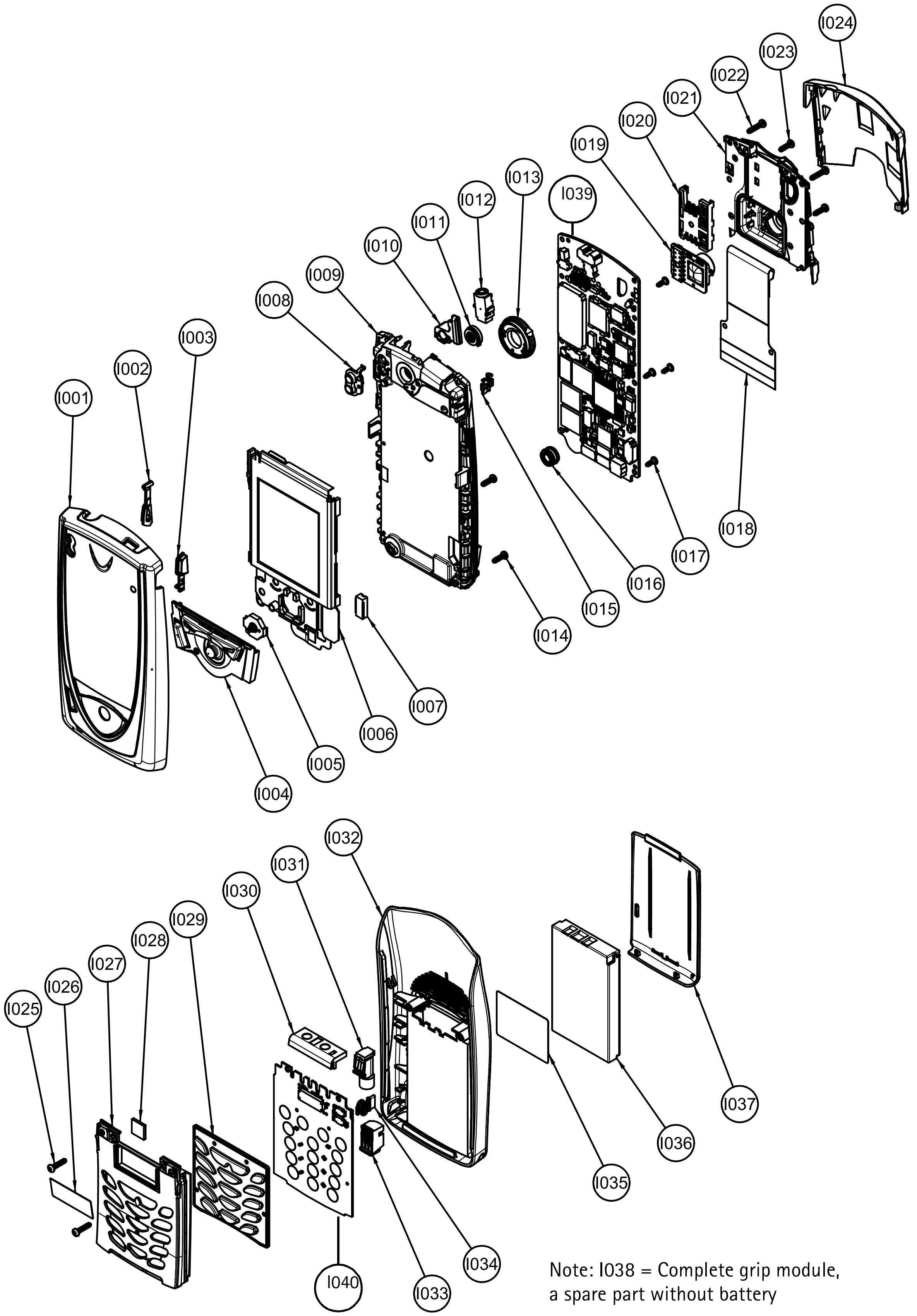
## Table of Contents

## Exploded Diagram of NHL-2NA

**Figure 1: Exploded diagram of NHL-2NA**




Note: I038 = Complete grip module, a spare part without battery

## List of Mechanic Parts

| Item | Code | Qty | Part name | Part type |
|---|---|---|---|---|
| I001 | 9458224 | 1 | A-cover Assembly | DMC04037 |
| I002 | 9790529 | 1 | Voice Record Key | DMC04034 |
| I003 | 9790530 | 1 | Power Key | DMC04035 |
| I004 | 9790535 | 1 | Transceiver Keymat Assy | DMC04038 |
| I005 | 5200047 | 1 | Sm Sw 5way Navigation Key | |
| I006 | 4850243 | 1 | UI Module Assy | HDB15 |
| I007 | 5469169 | 1 | Sm Conn 2x15f P0.5 | 50V 0.3A BTB |
| I008 | 9458256 | 1 | Proximity Windows | DMC04040 |
| I009 | 9467067 | 1 | Chassis main assy | DMC04028 |
| I010 | 9460416 | 1 | Proximity Rubber | DMD07587 |
| I011 | 5140247 | 1 | Speaker 105+-3db | 32R D8X2MM PICO |
| I012 | 5409119 | 1 | Sm Jack 2.5mm 5pol+sw | SPR 90DEG |
| I013 | 5140255 | 1 | Speaker 78+-2db | 8R D16.2X3.8 |
| I014 | 6290119 | 2 | Screw 1.8x6 Rf T6+ Blk | DMD06930 |
| I015 | 5200049 | 1 | Sm Sw Dome | 42VDC 100MA |
| I016 | 5140261 | 1 | Cond.mic 40+-2db | 2.2K D7.5X4.1 |
| I017 | 6290117 | 4 | Screw 1.6x4.4 Rff T5+ Bl | DMD06931 |
| I018 | 0201759 | 1 | L4 Grip flex | FLEX MODULE |
| I019 | 4858001 | 1 | Vga Camera Module | TCM8002MD |
| I020 | 5409215 | 1 | Sm Sim Conn 2x3pol | P2.54 SPR |
| I021 | 9467064 | 1 | Acoustic Chamber Assy | DMC04047 |
| I022 | 6290093 | 2 | Screw 1.8x8 Fezn T6+ | DMD05615 BLK |
| I023 | 6290119 | 2 | Screw 1.8x6 Rf T6+ Blk | DMD06930 |
| I024 | 9458205 | 1 | B-cover Painted | DMC04077 |
| I025 | 6290093 | 2 | Screw 1.8x8 Fezn T6+ | DMD05615 BLK |
| I026 | 9480728 | 1 | Protection Tape | DMD07339 |
| I027 | 9458182 | 1 | Keymat Cover Assy | DMC03986 |
| I028 | 6490201 | 1 | Magnet | DMD07320 |
| I029 | 9794057 | 1 | Grip Keymat Assy | DMC03866 |
| I030 | 5400255 | 1 | Battery Connector | |
| I031 | 6800027 | 1 | Vib Motor Assy 1.3v | 120MA 6000RPM |

| Item | Code | Qty | Part name | Part type |
|---|---|---|---|---|
| I032 | 9458181 | 1 | Grip Cover Assy | DMC03987 |
| I033 | 5400251 | 1 | Dc Jack | |
| I034 | 9452255 | 1 | Locking Latch | DMD08345 |
| I035 | 9370931 | 1 | Type Label Reel Code | DMD07217 |
| I036 | 0670246 | | Battery Li-Ion | BLB-2 |
| I037 | 9452059 | 1 | Battery Cover | DMD07485 |
| I038 | 0257003 | 1 | LS4 Grip module | ITU-T |
| I039 | | 1 | LG4 PWB | |
| I040 | | 1 | LS4 PWB | |

# Service Software Instructions & Service Concepts

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## Table of Contents

# Service Software Phoenix

*Note: Please refer to the Service Concepts section to check the correct way to connect the cables.*

## Phoenix Installation Steps in Brief

These are the basic steps to install the Phoenix

- Install the Phoenix Service SW
- Install the Data Package for Phoenix (product specific data and flash update package)
- Manage connection settings (depends on the tools you are using)
- Update FPS-8 SW (if you use FPS-8)
- Activate FPS-8
- Update JBV-1 Docking Station SW (only when needed)
- The flash update files are delivered with then Phoenix Data Package so unless you want to use certain version of this package, separate installation package is not needed anymore. If you want to use it, it should be installed after connection management, before FPS-8 update.

*Please refer to Technical Bulletins for more information concerning phone model specific service tools and equipment setup.*

## Phoenix Service SW

### Before Installation

- Check that a Dongle is attached to the parallel port of your computer.
- Download the installation package (e.g. *nhl2na_nhm4_nhm7_nhm8_npe4_npl1_npm9_03_72_002.exe*) to your computer (e.g. C:\TEMP)
- Close all other programs
- Run the application file (e.g. *nhl2na_nhm4_nhm7_nhm8_npe4_npl1_npm9_03_72_002.exe)* and follow instructions on the screen
- Administrator rights may be required to be able to install Phoenix depending on the Operating System
- If dongle driver is installed or updated, you need to reboot your PC before the installation can continue.
- If uninstalling or rebooting is needed at any point, you will be prompted by the Install Shield program.

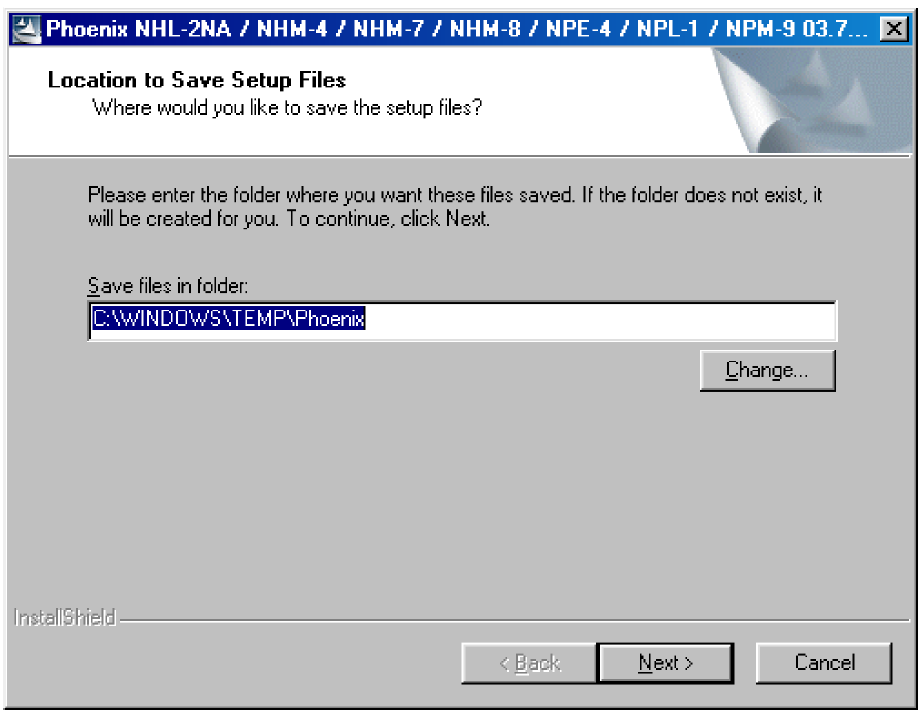
If at any point during installation you get this message, *"Dongle is not found and installation can´t continue*", the possible reasons may be a defective or too old PKD-1Dongle (five digit serial number Dongle when used with FPS-8 Prommer) or that the FLS-4S POS Flash Dongle is defective or power is not supplied by external charger.

Check the COM/parallel ports used first! After correcting the problem Installation can be restarted.

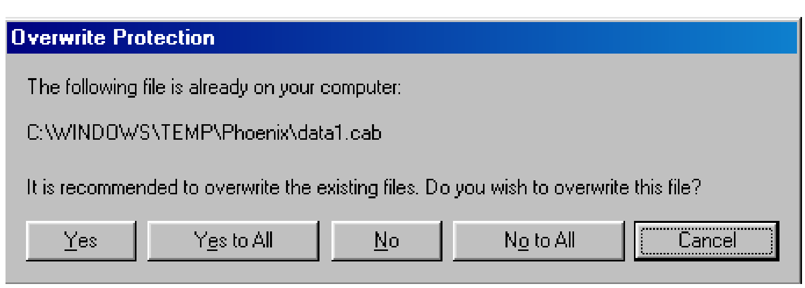

## Startup

Run the nhl2na_nhm4_nhm7_nhm8_npe4_npl1_npm9_03_72_002.exe to start installation.

When you choose “Next” the files needed for installation will be extracted. Please wait...



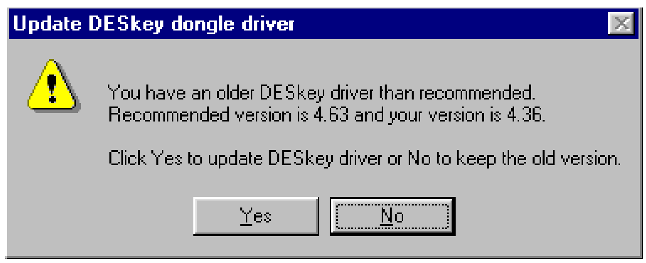

If the setup files are already extracted (left in the file system from previous installation) following dialog appears. Always click "Yes to All" to overwrite the existing setup files.



### Dongle Driver Installation and Version Check

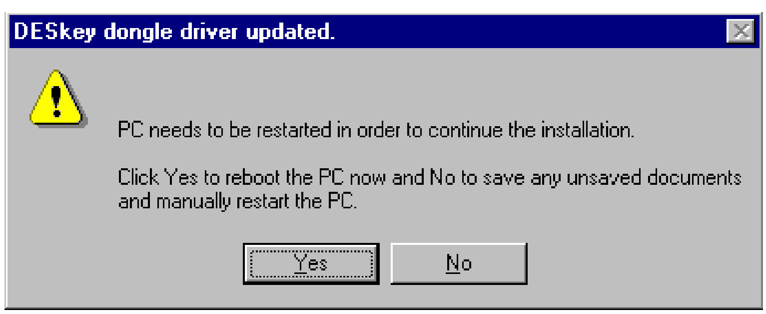
If there is no previously installed Dongle driver, installation will take place.


If Dongle driver is installed and it is older than the latest supported version, the latest version will be installed when you choose "Yes". The latest version is always included in the latest Phoenix installation package.



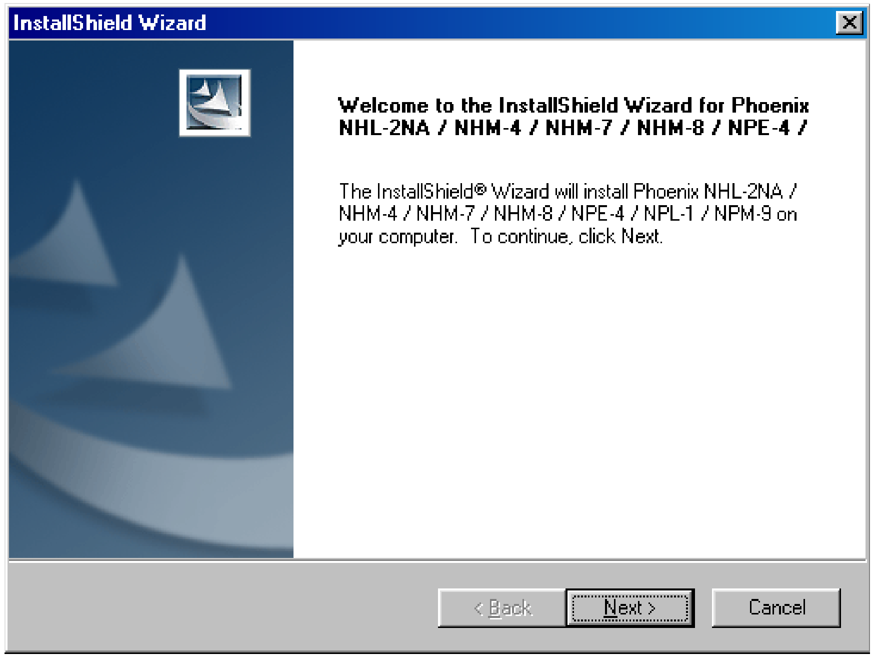

PC needs to be rebooted before installation can continue. Click "Yes" to reboot the PC.

Setup is restarted automatically after reboot.



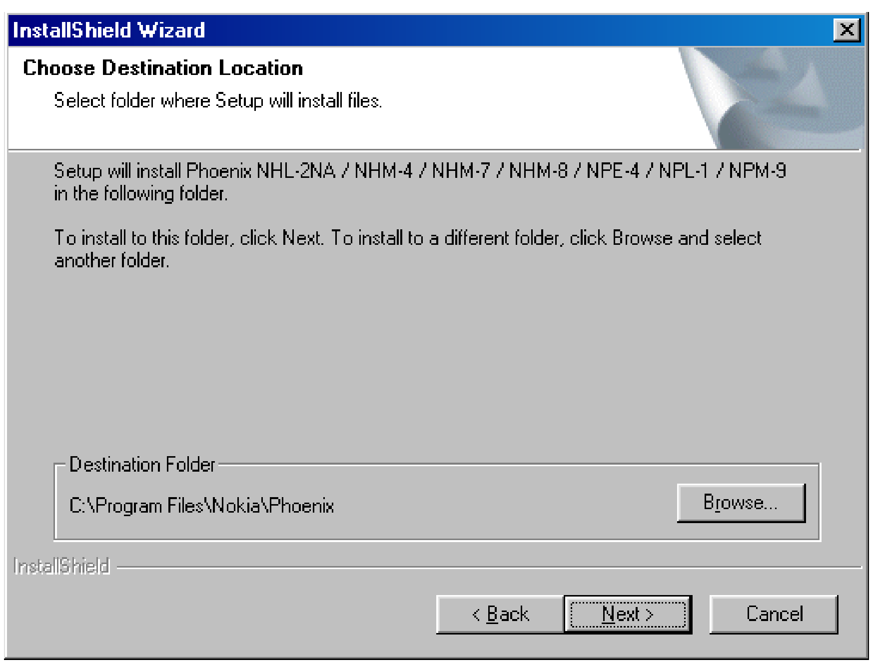

### First Time Installation of Phoenix

After Dongle driver installation / update (if needed) installation continues from this step. Click "Next" in Welcome dialog to continue.

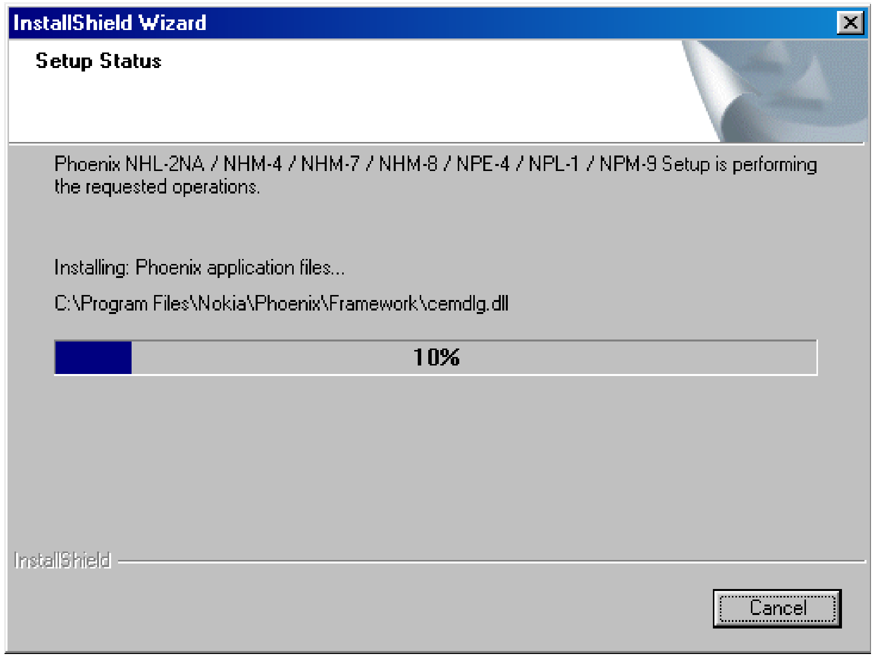



Choose destination folder, it is recommended to use the default folder *C:\Program-Files\Nokia\Phoenix*.

Choose "Next" to continue. You may choose another location by selecting "Browse" (<u>not recommended</u>)



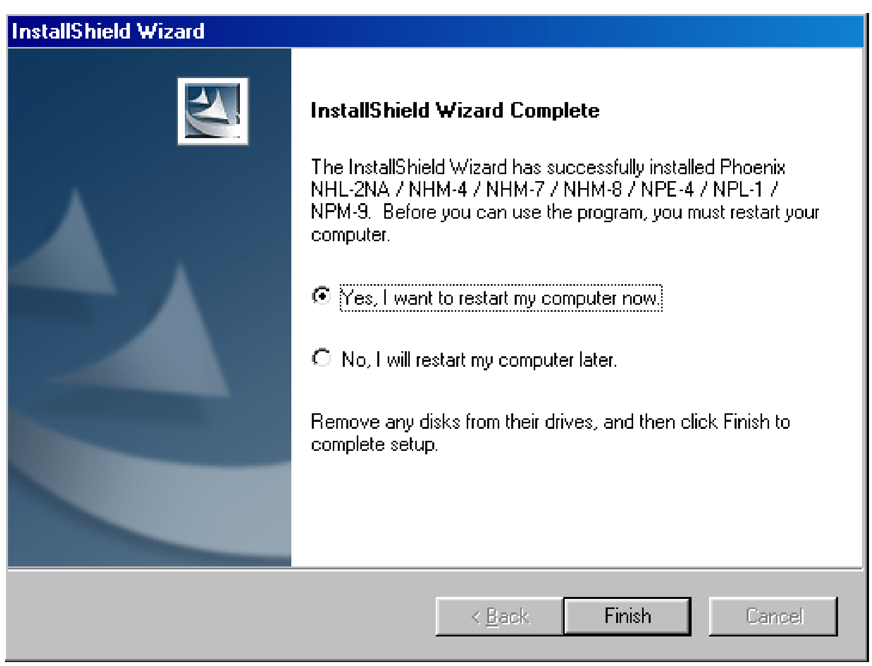

Setup copies the components. Please wait. Progress of the setup is shown. Please wait...




**If restarting of your computer is needed** the Install Shield Wizard will tell you about it.

Select "Yes..." to reboot the PC immediately and "No..." to reboot the PC manually.

Note that Phoenix doesn't work, if components are not registered. Click “Finish” to continue.

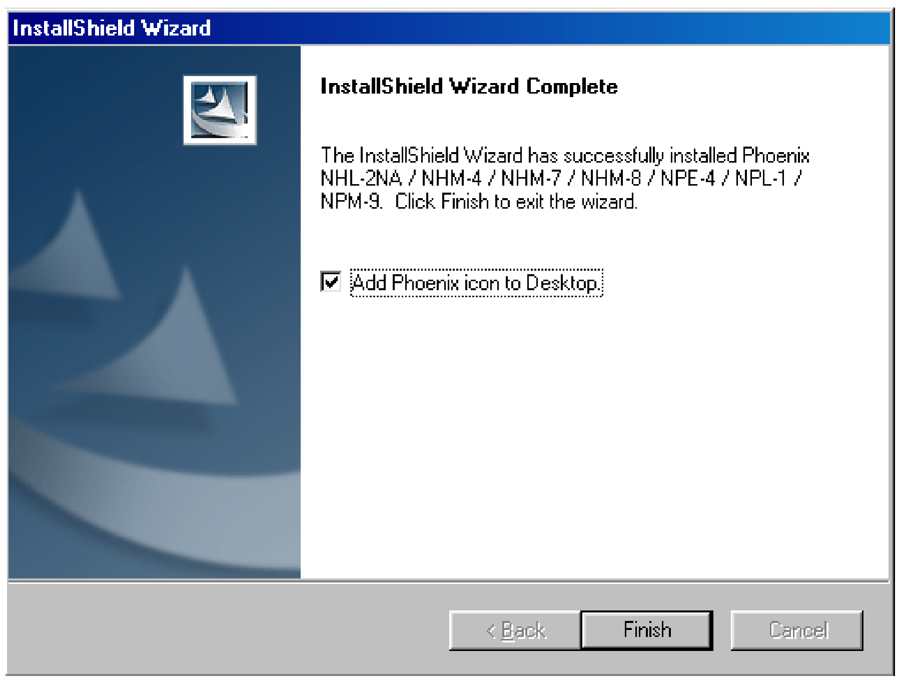



After the reboot components are registered and Phoenix is ready for use.

If reboot is not needed components are registered after copying them.


**If restarting of your computer is not needed,** this view will be shown instead.

Click "Finish" to exit the setup. Phoenix is now ready for use.




Now the installation of Phoenix Service SW is ready and it can be used after:

- Installing Phone model specific Phone Data Package for Phoenix
- Configuring the connections
- Updating the Flash Update Package files used with FPS-8* and FLS-4* tools

### Update Installation of Phoenix

If you already have the Phoenix Service SW installed on your computer, sooner or later there will be need to update it when new versions are released.

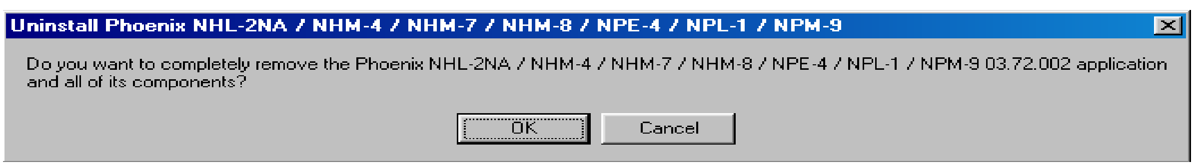
Please note that very often the Phoenix Service SW and the Phone Specific Data Package for Phoenix come in pairs, meaning that certain version of Phoenix can only be used with certain version of Data Package. Always use the latest available versions of both. Instructions can be found in phone model specific Technical Bulletins.

To update the Phoenix you need to take exactly the same steps as when installing it for the first time.

- Download the installation package to your computer hard disk
- Close all other programs
- Run the application file (e.g. *nhl2na_nhm4_nhm7_nhm8_npe4_npl1_npm9_03_72_002.exe*)
- Dongle driver version will be checked and if need be, updated
- After reboot installation starts automatically
- Newer version of Phoenix will be installed

When you update the Phoenix from old to new version (e.g. update from 03.65.00 to 03.72.002), the update will take place automatically without uninstallation

If you try update the Phoenix with the same version that you already have (e.g. 03.72.002 to 03.72.002) you are asked if you want to uninstall the version of Phoenix you have on your PC. Answer “OK” to uninstall Phoenix, “Cancel” if you don’t want to uninstall.




If you try to install an older version (e.g. downgrade from 03.72.002 to 03.55.000) installation will be interrupted

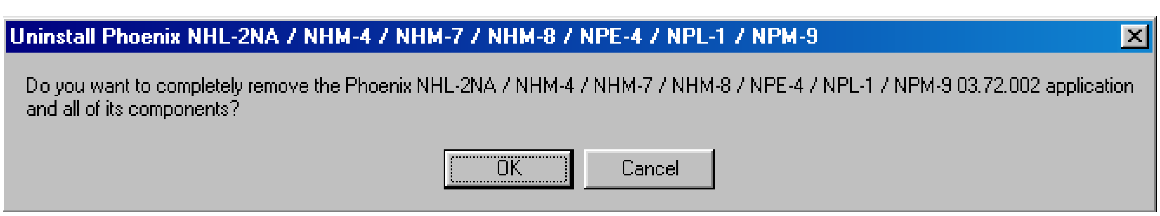
Please always follow the instructions on the screen.

## How to Uninstall Phoenix

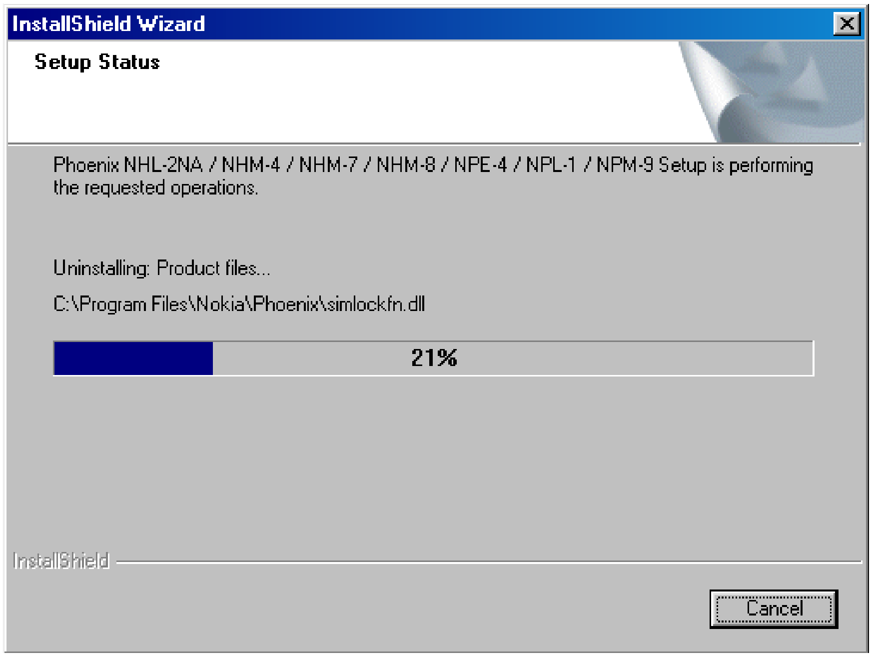
Uninstallation can be done manually from Windows Control Panel - Add / Remove Programs.

Choose “Phoenix NHL-2NA / NHM-4 / NHM-7 / NHM-8 / NPE-4 / NPL-1 / NPE-9 Release” click "Add/Remove".

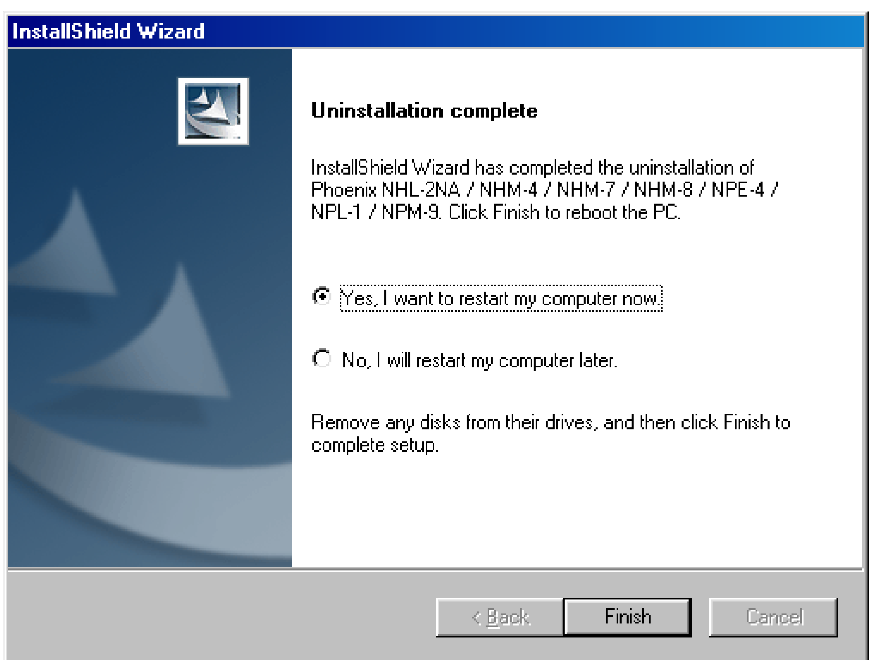
Choose “OK” to uninstall



Progress of the uninstallation is shown.




You might have to reboot the PC after uninstallation.




*Note: If you have different product packages installed, components are uninstalled only if they are not included in other product packages.*

## Data Package for Phoenix (Product Specific)

### Before installation

- Product Data Package contains all product specific data to make the Phoenix Service Software and tools usable with a certain phone model.
- It also includes the latest version of flash update package for FLS-4* and FPS-8*
- Check that the Dongle is attached to the parallel port of your computer.
- Install Phoenix Service SW
- Download the installation package (e.g. *NHL-2NA_dp_v_3.08.exe*) to your computer (e.g. C:\TEMP)
- Close all other programs
- Run the application file (e.g. *NHL-2NA_dp_v_3.08.exe*) and follow instructions on the screen

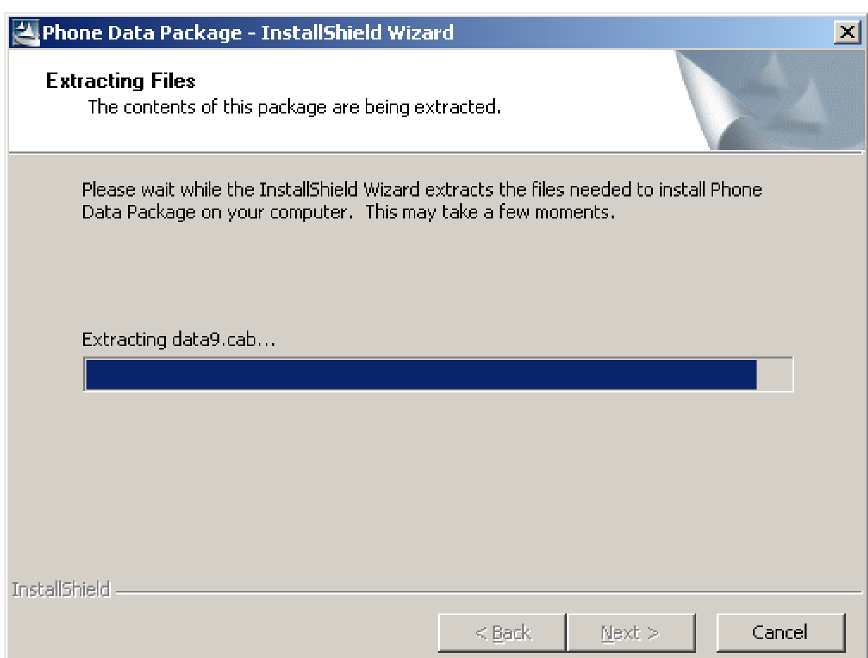
If you already have the Phoenix Service SW installed on your computer, sooner or later there will be need to update it when new versions are released.

*Please note that very often the Phoenix Service SW and the Phone Specific Data Package for Phoenix come in pairs*, meaning that certain version of Phoenix can only be used with certain version of Data Package. Always use the latest available versions of both. Instructions can be found in phone model specific Technical Bulletins.

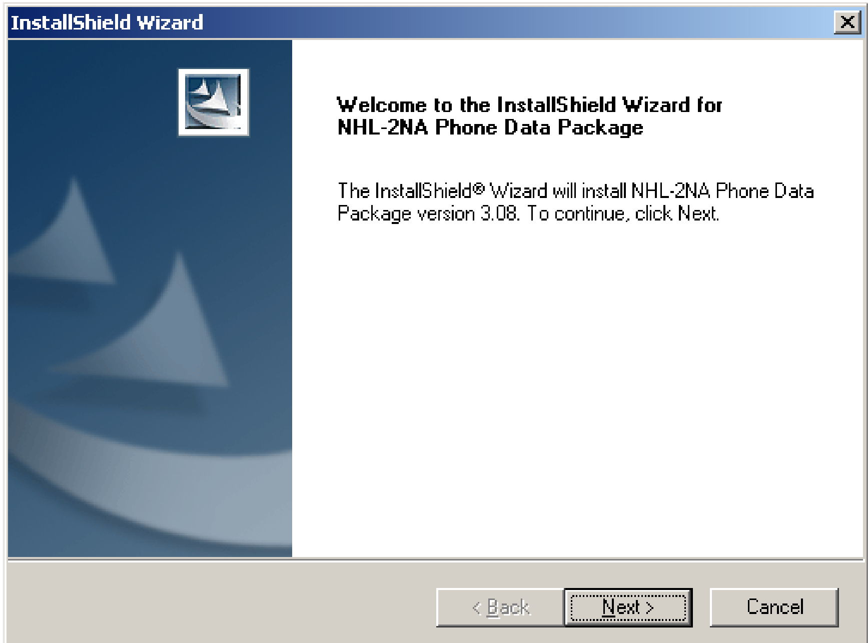
### Installation of Phoenix Data Package (Product Specific)

Run the *NHL-2NA_dp_v_3.08.exe* to start installation.

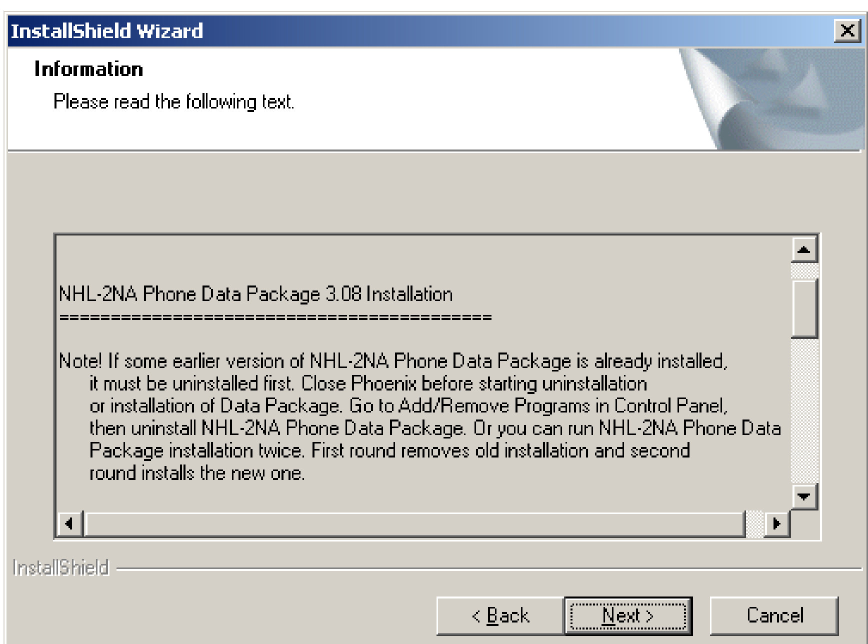
When you choose "Next" the files needed for installation will be extracted. Please wait...



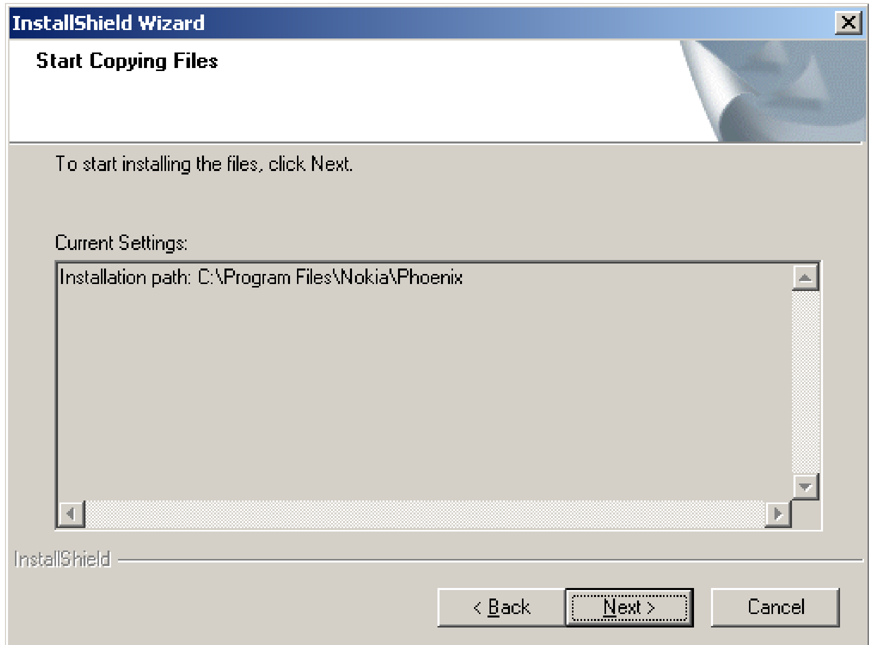
Choose “Next” to continue.



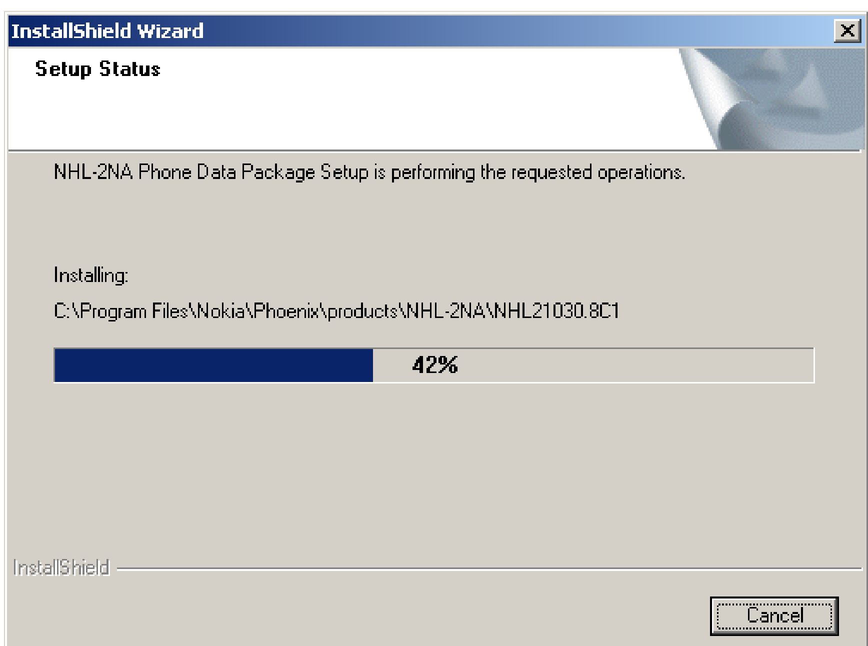

From this view you can see the contents of the Data Package. **Read the text carefully.** There should be information about the Phoenix version needed with this data package. Choose “Next”.



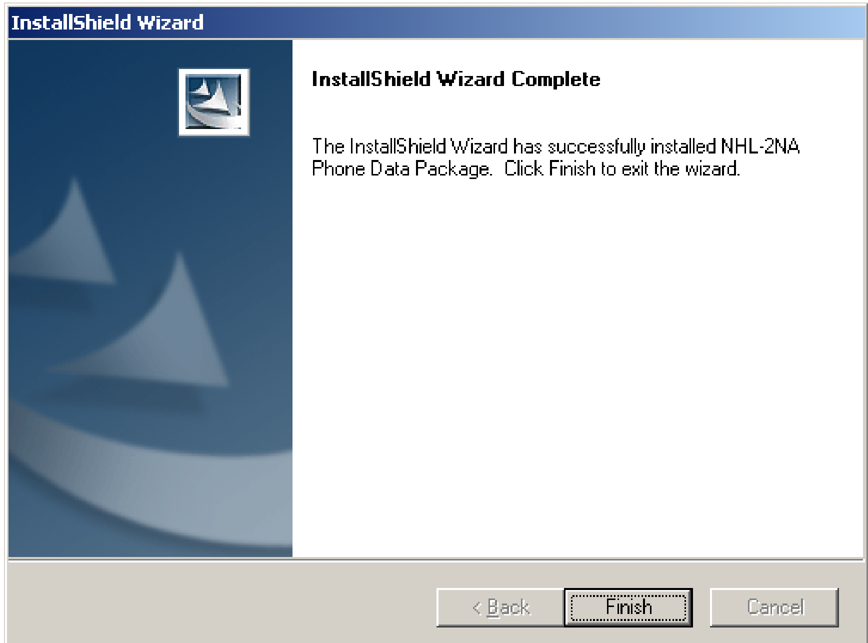

Confirm location and choose “Next” to continue. Install shield checks where the Phoenix application is installed and the directory is shown. Choose “Next” to continue.




Phone model specific files will be installed. Please wait




Choose “Finish” to complete installation




You now have all phone model specific files installed in your Phoenix Service SW.

### How to Uninstall Data Package

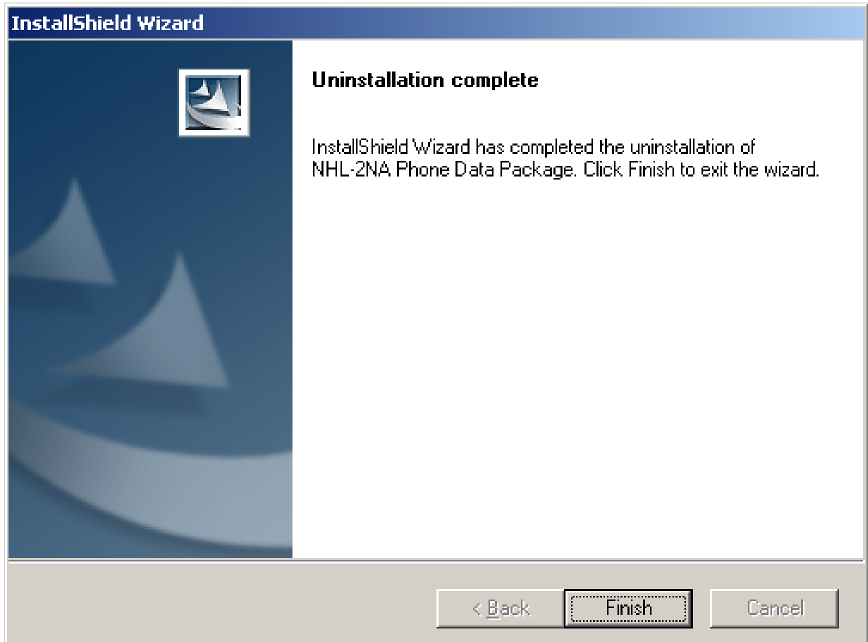
Uninstallation can also be done manually from Windows Control Panel / Add / Remove Programs/

"NHL-2NA Phone Data Package".

If you try to install the same version of Phoenix Data Package that you already have, you are asked if you want to unistall the version you have on your PC. Answer "OK" to uninstall, "Cancel" if you don't want to uninstall. Older versions of data packages do not need to be uninstalled.


Once the previously installed Data package is uninstalled, choose "Finish".

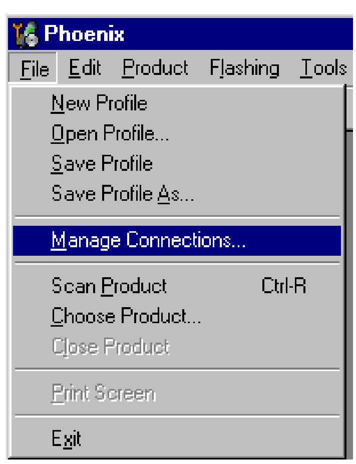



Run the *NHL-2NA_dp_v_3.08.exe* again to continue installation from the beginning.

## How to Manage Connections

Start Phoenix Service SW and Login.

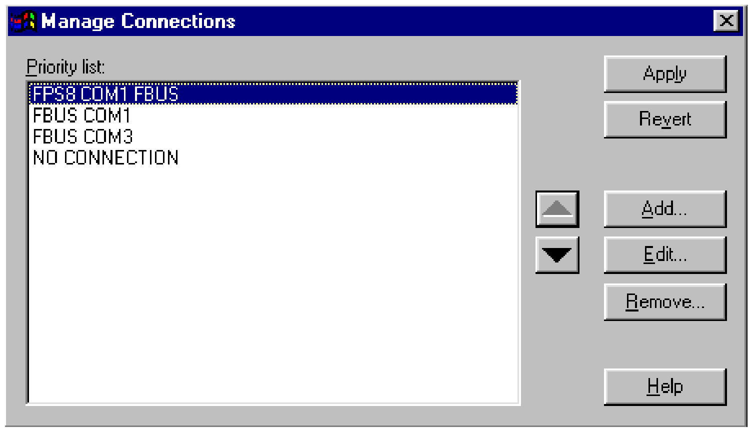

Choose “Manage Connections” From “File” – Menu




Existing connections can be selected, edited, deleted and new ones created by using this dialog.

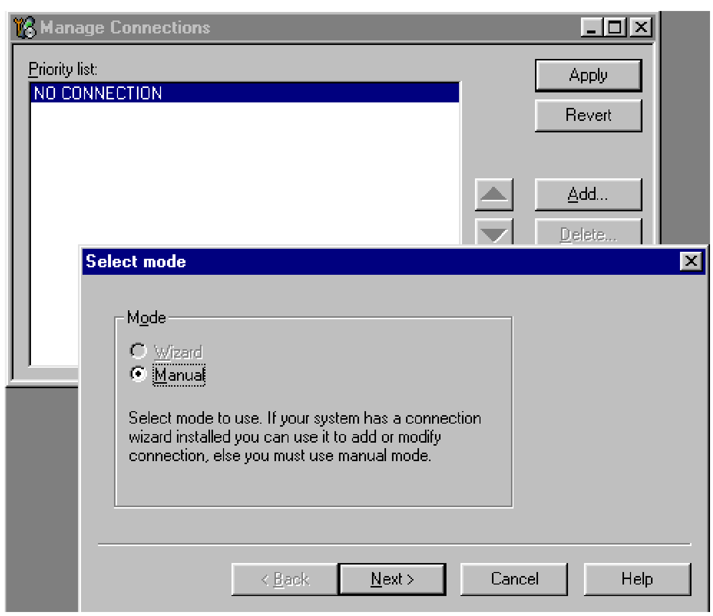
A connection can be created either manually or by using a Connection Wizard.

To add new connection, choose "Add" and select if you want to create it manually or by using the Wizard.




Choose "Next" to continue.

In the next dialogs you will be asked to select some settings for the connection




**Manual Settings**

**A)** For **FLS-4 POS Flash Device** choose following connection settings

- **Media:** FBUS
- **COM Port:** Virtual COM Port used by FLS-4 **Please check this always!**

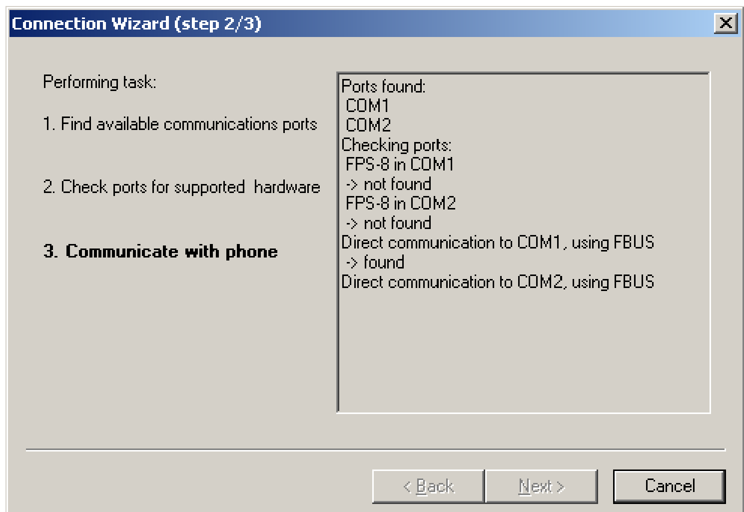
(To check please go to Windows / Control Panel / FLS Virtual Port / Configuration)

**B)** For **FPS-8 Flash Prommer** choose following connection settings:

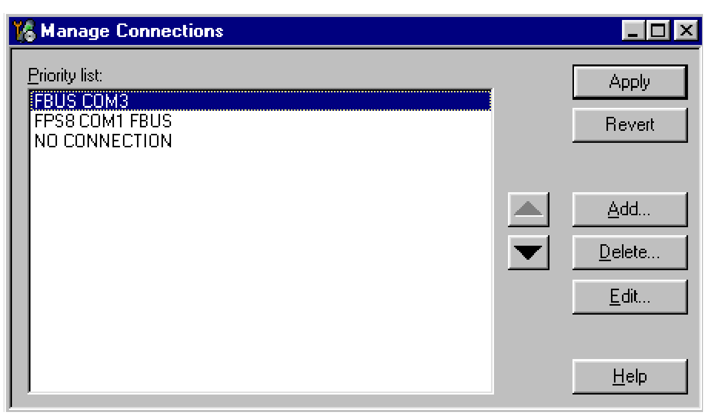
- **Media:** FPS-8
- **Port Num:** COM Port where FPS-8 is connected
- **COMBOX_DEF_MEDIA:** FBUS

Choose “Finish” to complete.

If you use the Wizard, connect the tools and a phone to your PC and the wizard will automatically try to configure the correct connection,

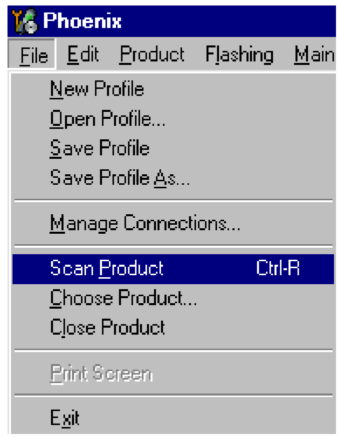



Activate the connection you want to use by clicking it and use up/down arrows to move it on top of the list. Choose “Apply”. The connection is now selected and can be used after closing the “Manage Connections” window




Selected connection will be shown on the right hand bottom corner of the screen

To use the selected connection, connect the phone to Phoenix with correct service tools, make sure that it is switched on and select “Scan Product”.




When Product is found, Phoenix will load product support and when everything is ready, name of the loaded product support module and its version will be shown on the bottom of the screen.


## How to Update Flash Support Files for FPS-8* and FLS-4*

### Before Installation

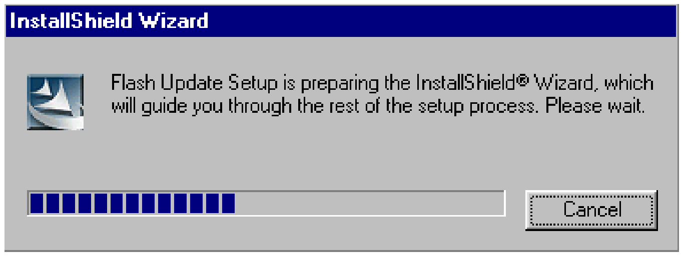
- Install Phoenix Service SW and Phoenix data package
- Download the installation package (e.g. *flash_update_02_06_001.exe*) to your computer (e.g. C:\TEMP)
- Close all other programs
- Run the application file (e.g. *flash_update_02_06_001.exe)* and follow instructions on the screen

Note:

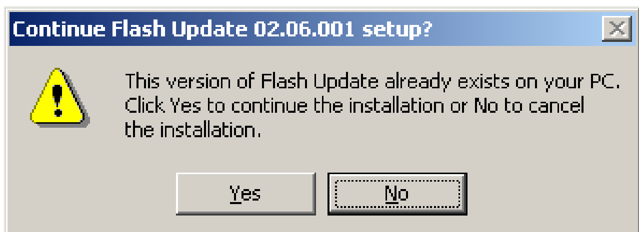
- The flash support files are delivered in the same installation package with Phoenix data package.
- Normally it is enough to install the data package only before updating the FPS-8.
- Separate installation package for flash support files is available, and the files can be updated according to this instruction.

### Installing the Flash Support Files

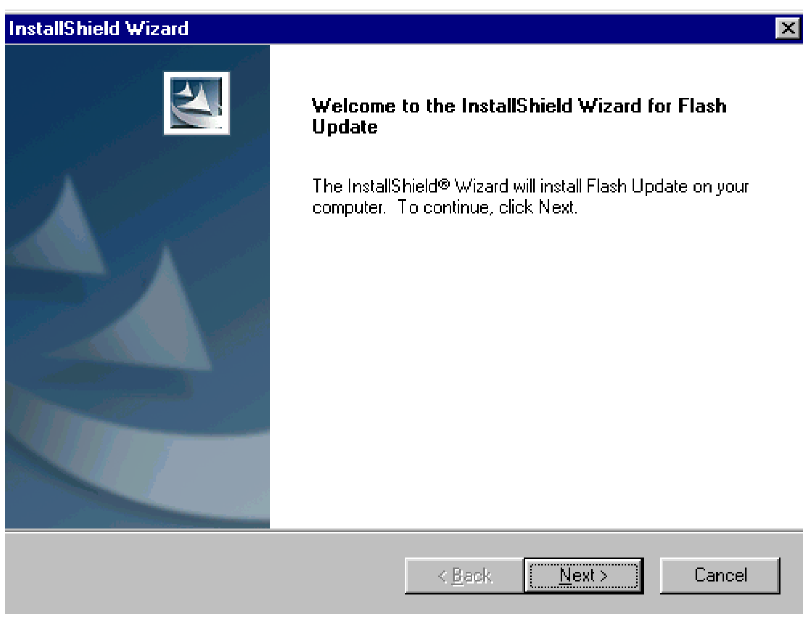
Start by double clicking *flash_update_02_06_001.exe*. Installation begins.



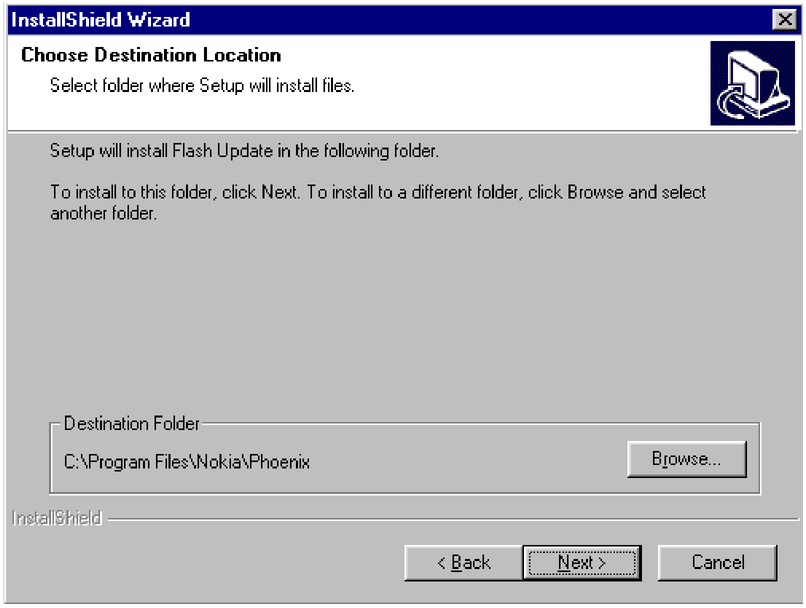

If you already have the same Flash Update package files installed, you need to confirm if you want them to be reinstalled.



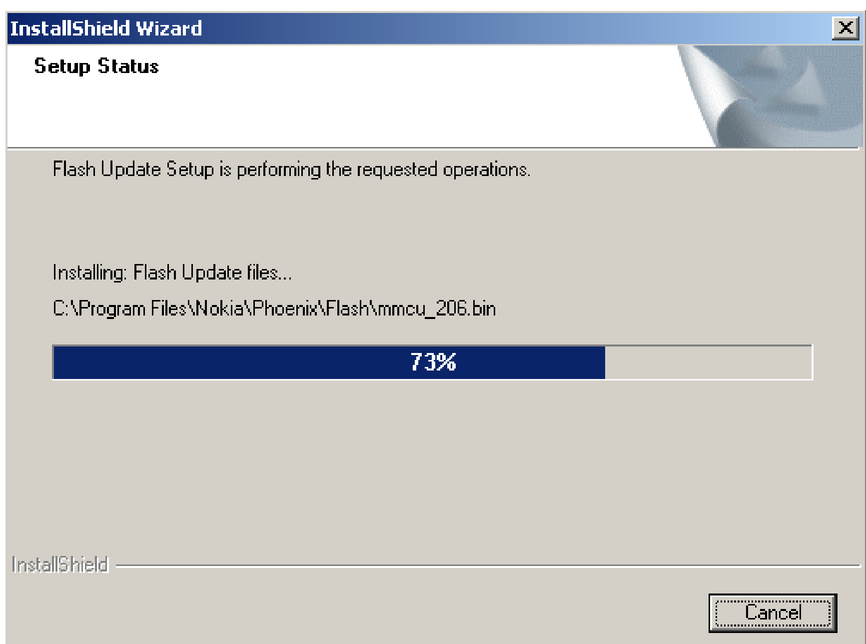

Choose “Next” to continue installation




It is **highly** recommended to install the files to the default destination folder *C:\Program Files\Nokia\Phoenix*. Choose “Next” to continue. You may choose another location by selecting “Browse” (not recommended)

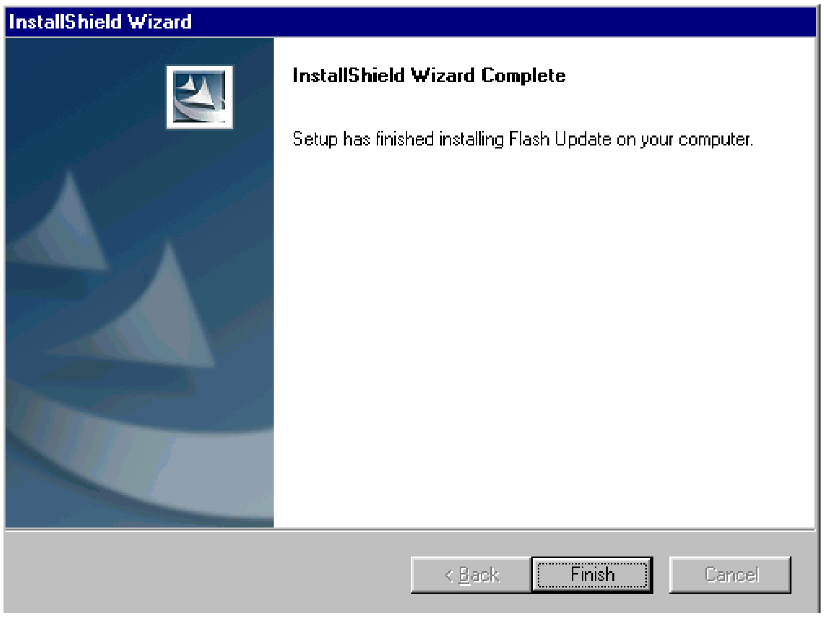



Installation continues...




Choose "Finish" to complete procedure.

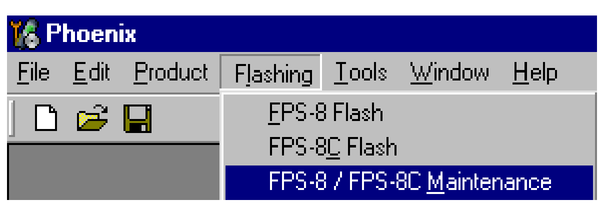
- FLS-4 can be used right after Flash Update Package is installed.
- FPS-8* must be updated by using Phoenix!



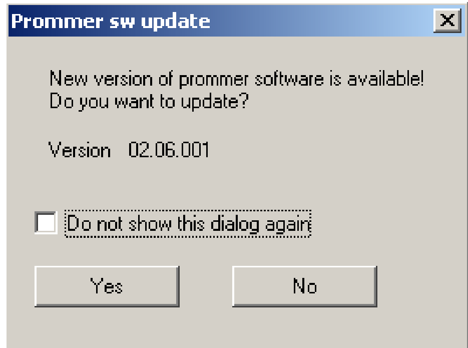

## How to Update The FPS-8* Flash Prommer SW

Start Phoenix Service Software.

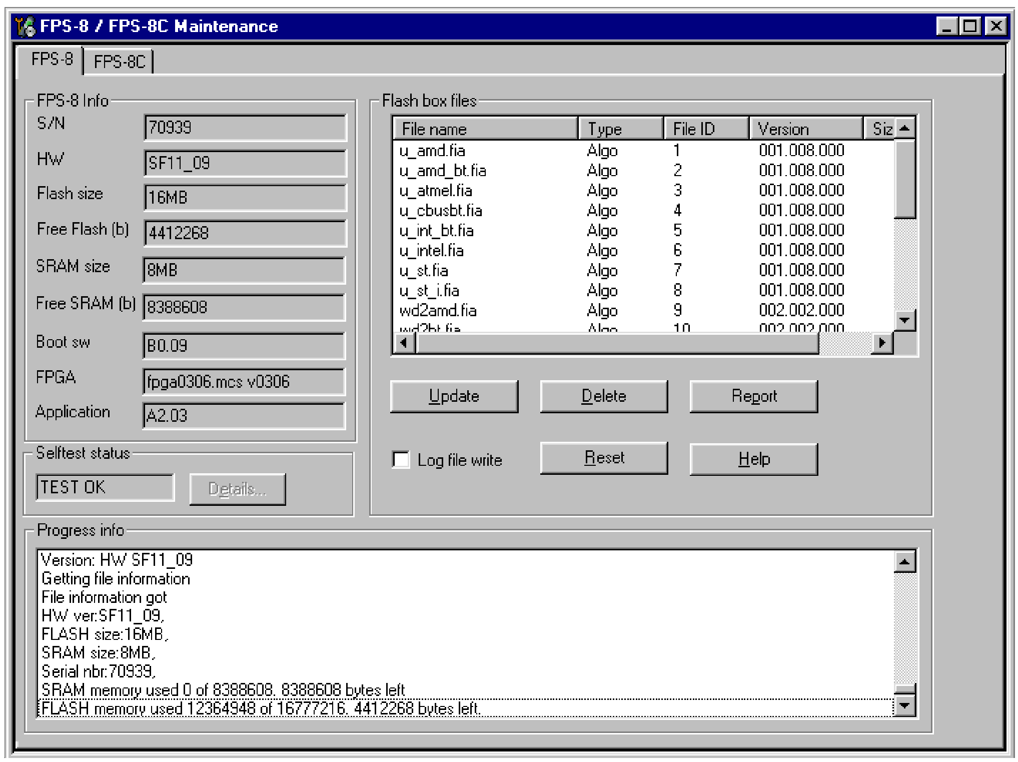

Select "FPS-8 / FPS-8C maintenance" from "Flashing" menu



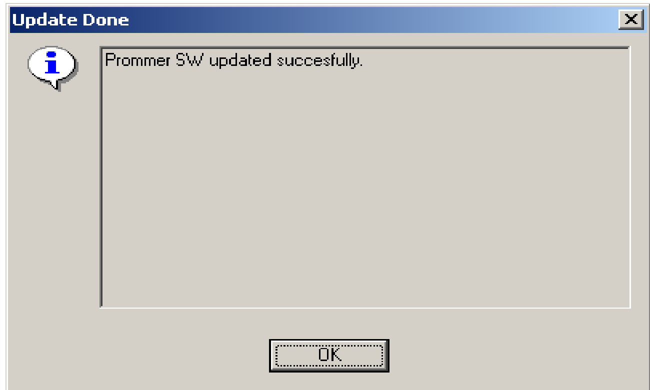

When new FPS-8 flash update package is installed to computer you will be asked to update the files to FPS-8 Prommer. Select "Yes" to update files.




Update procedure takes a couple of minutes, please wait.

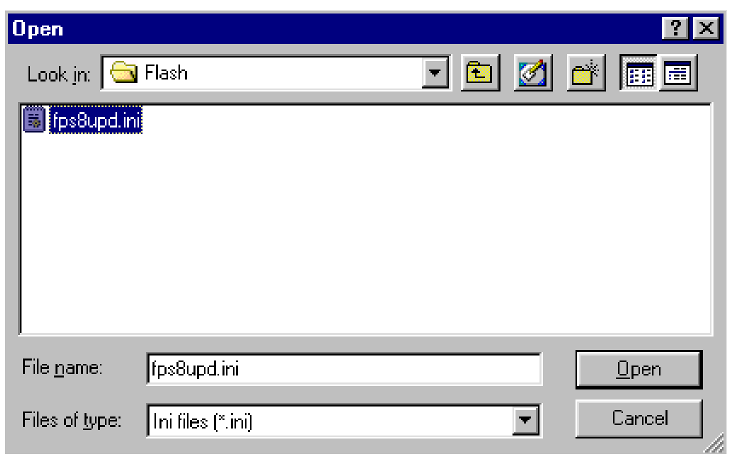



Following dialog appears after FPS-8 is updated.




FPS-8 sw can also be updated by pressing "Update" button and selecting appropriate **fps8upd.ini** file

Under *C:\Program Files\Nokia\Phoenix***Flash** - directory




All files can be loaded separately to FPS-8. To do this, just press right mouse button in "Flash box files" window and select file type to be loaded.

More information and help can be found from "Help" dialog

## FPS-8 Activation and Deactivation

- Before the FPS-8 can be successfully used for phone programming, it must be first activated.
- If there is a need to send FPS-8 box to somewhere e.g. for repair, box must be first deactivated.

*Note: Phoenix should be closed before running BoxActivation.exe.*

### Activation

Before FPS-8 can be successfully used for phone programming, it must be first activated.

Fill in first “FPS-8 activation request” sheet, in the FPS-8 sales package and follow the instructions in the sheet.

When activation file is received (e.g. 00000.in), copy it to *C:\ProgramFiles\Nokia\Phoenix\BoxActivation* - Directory on your computer

(This directory is created when Phoenix is installed).

Start *BoxActivation.exe* from *C:\ProgramFiles\Nokia\Phoenix\BoxActivation* – directory.

*Fo*llow the instructions in the screen.

1 Choose correct COM Port where your FPS-8 is connected
2 Information about the FPS-8 is shown
3 Choose “Activate the Box”
4 Activation file will be shown, check that it is correct
5 Box will be activated and updated information is shown
6 Turn FPS-8 power off and on to complete activation

**Deactivation**

Start *BoxActivation.exe* from *C:\ProgramFiles\Nokia\Phoenix\BoxActivation* directory and follow the instructions in the screen.

1 Choose correct COM Port where your FPS-8 is connected
2 Information about the FPS-8 is shown
3 Choose “Deactivate the Box”
4 Confirm Deactivation.
5 Box will be deactivated, please exit BoxActivation
6 Turn FPS-8 power off and on to complete deactivation

## JBV-1 Docking Station SW

The JBV-1 Docking Station is a common tool for all DCT-4 generation products.

In order to make the JBV-1 usable with different phone models, a phone specific Docking Station Adapter is used for different service functions.

The JBV-1 Docking Station contains Software (Firmware) which can be updated.

You need the following equipment to be able to update JBV-1 software:

- PC with USB connection
- Operating System supporting USB (Not Win 95 or NT)
- USB Cable (Can be purchased from shops or suppliers providing PC hardware and accessories)
- JBV-1 Docking Station
- External Power Supply 11-16V

## Before Installation

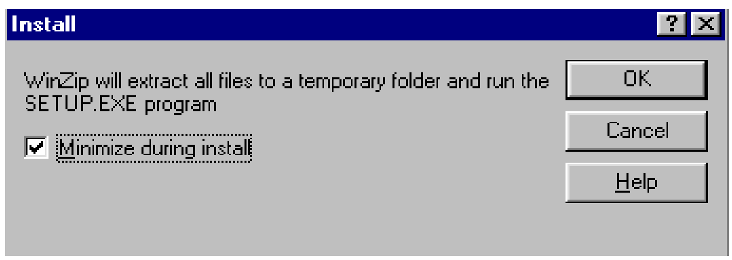
- Download *Jbv1_update.zip* – file to your computer (e.g. C:\TEMP) from your download web site.
- Close all other programs
- Follow instructions on the screen

## Installing SW Needed for the JBV-1 SW Update

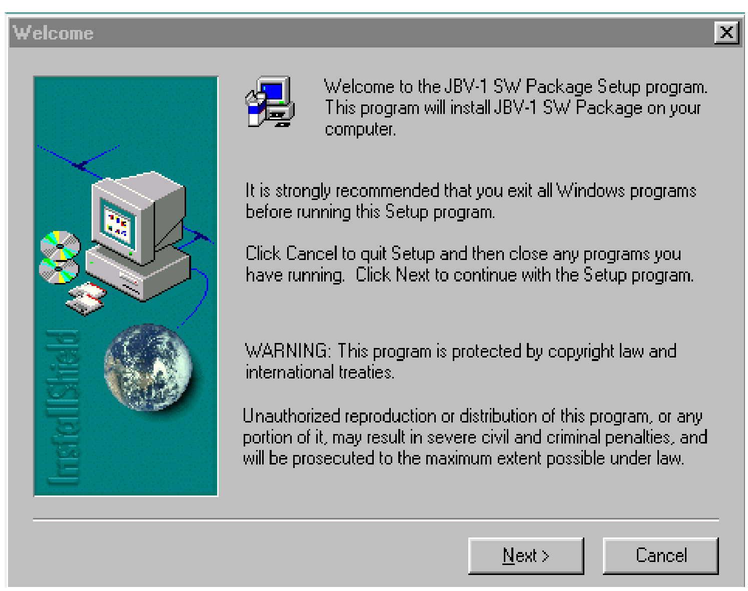
*Note: DO NOT CONNECT THE USB CABLE / JBV-1 TO YOUR COMPUTER YET!*

Run *Jbv1_update.zip* file and start SW Installation by double clicking *Setup.exe.*

Files needed for JBV-1 Package setup Program will be extracted.

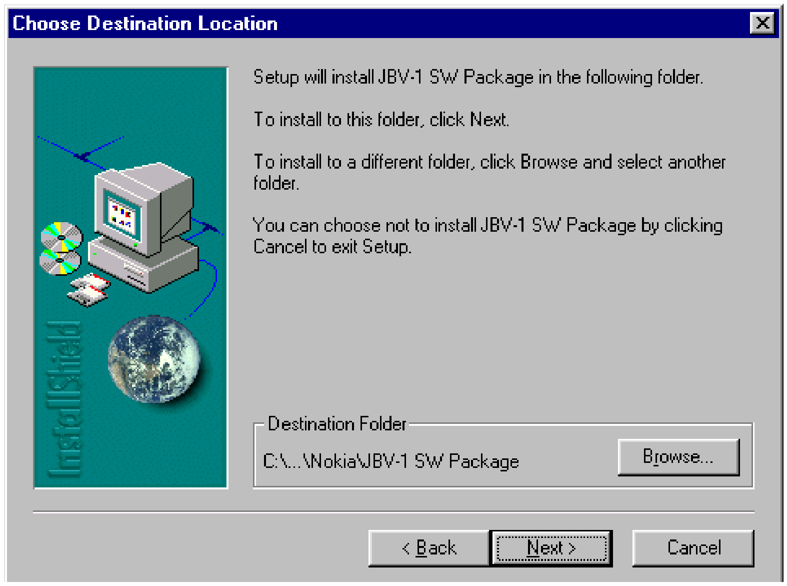



Installation begins, please read the information shown and Choose "Next" to continue

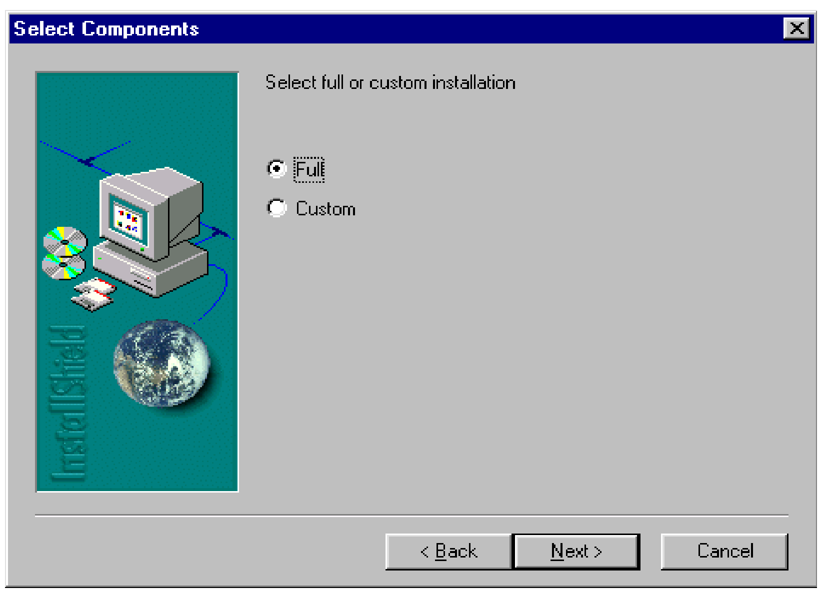



Use suggested destination folder where JBV-1 SW Package will be installed and

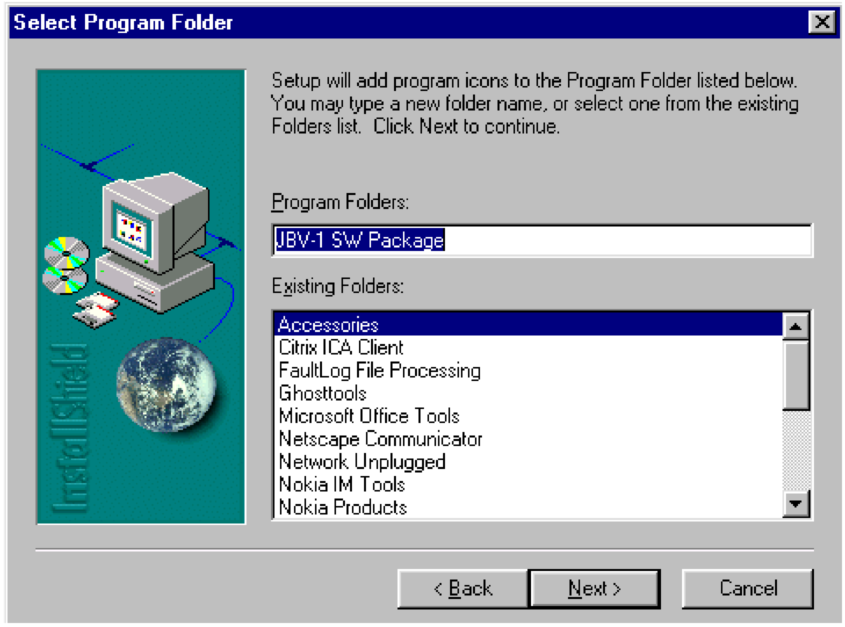
Choose "Next" to continue



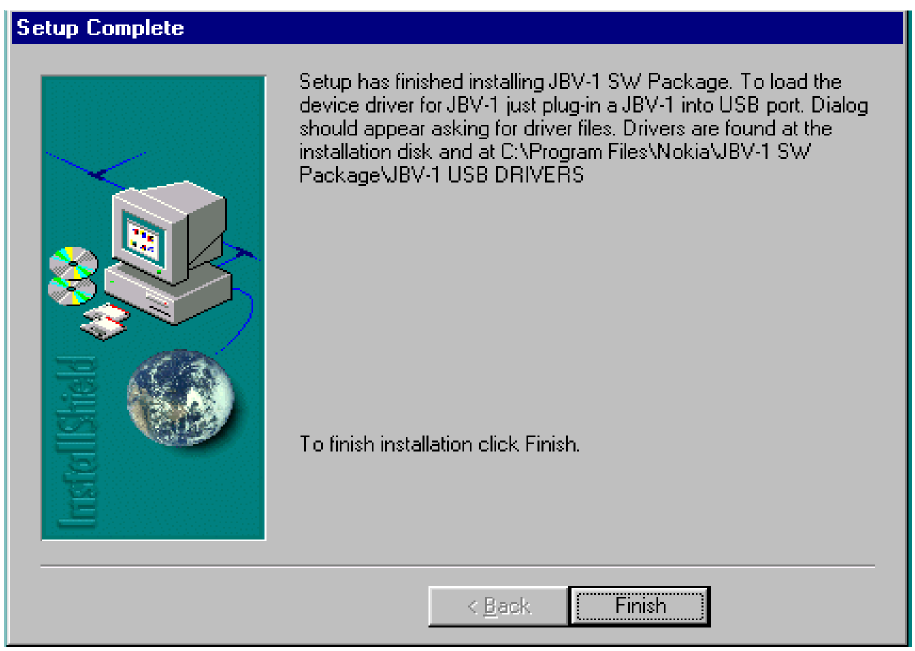

Select “Full” Installation and choose “Next” to continue




Program Folder will be created. Choose “Next” to continue, Software files will be installed




After successful installation, choose “Finish” to complete.

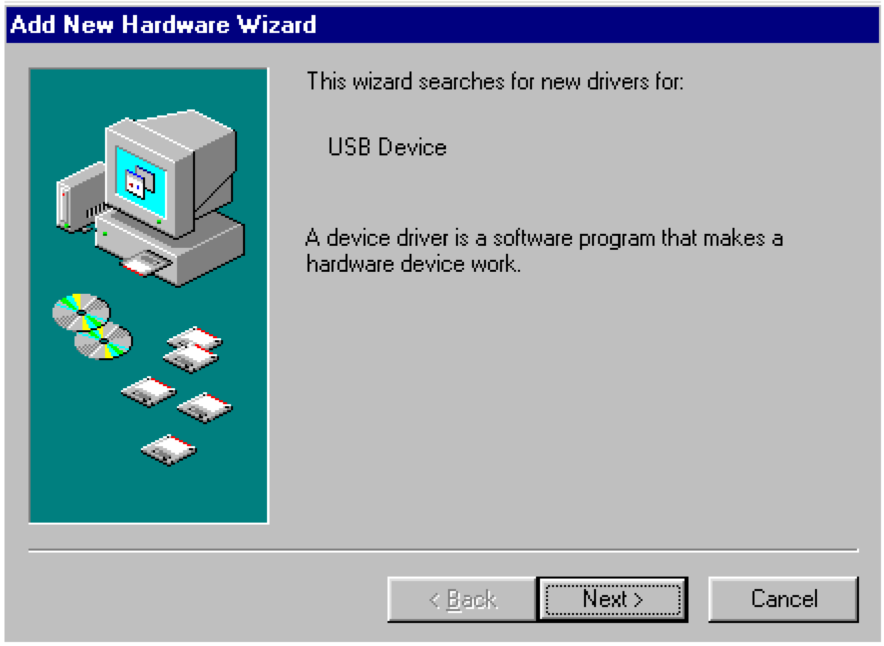



NOW YOU CAN CONNECT THE USB CABLE / JBV-1 TO YOUR COMPUTER

Connect power to JBV-1 (11-16V DC) from external power supply, then connect USB Cable between JBV-1 USB connector and PC.

Windows will detect connected USB cable and detect drivers for new HW.
Please follow the instructions and allow Windows to search and install the best

Drivers available. After this procedure the actual JBV-1 SW update can begin.

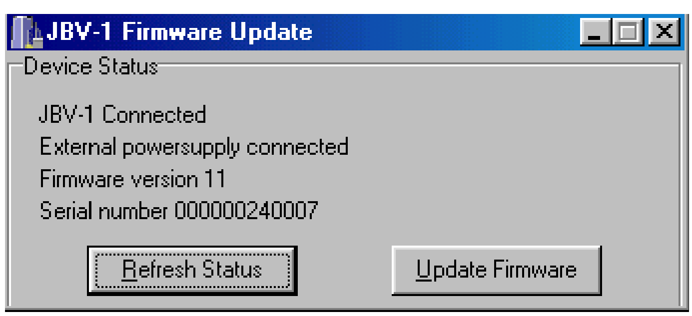



**Updating the JBV-1 Docking Station Software**

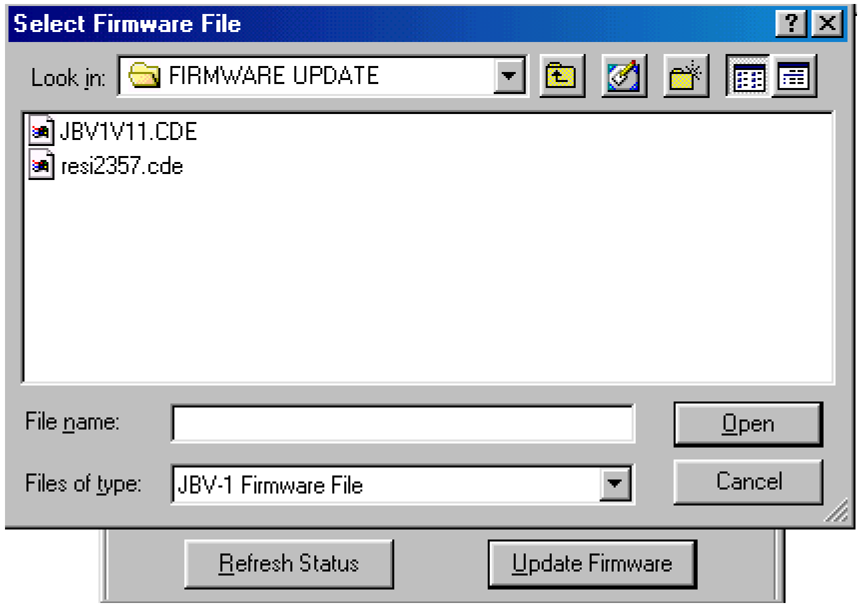
Go to folder *C:\Program Files\Nokia\ JBV-1 SW Package\ FIRMWARE UPDATE* and start JBV-1 Update SW by double clicking *fwup.exe.*

JBV-1 Firmware update starts and shows current status of the JBV-1 connected.

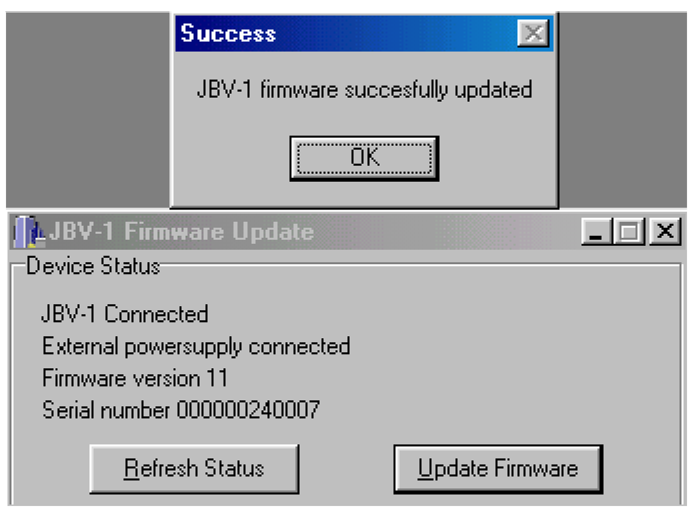
If firmware version read from your JBV-1 is not the latest one available, it needs to be updated by choosing "Update Firmware"




Choose file *JBV1v11.CDE* (example used here is for v 11) and "Open" to update your JBV-1




After successful update, current JBV-1 status will be shown. You have now updated the software of your JBV-1 docking station and it is ready for use.

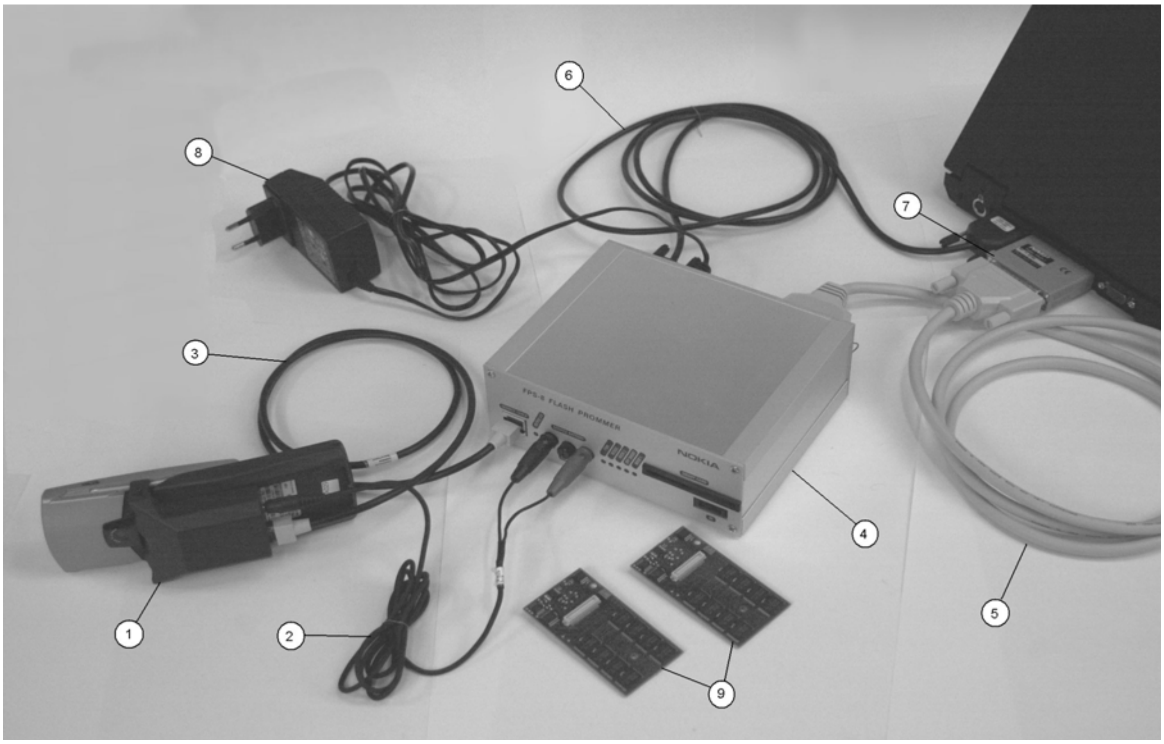


# SW update flashing setup

## Equipment list

The following equipment is need for NHL-2NA AMS SW update:

Figure 1: Setup for flashing




List of equipment:

Connecting NHL-2NA to PC with FPS-8, list of equipment which is needed:

| Item | Description | Type | Code |
|---|---|---|---|
| 1 | Point of Sales flash loading adapter | FLA-21 | 0775284 |
| 2 | power cable | FLC-2 | 0730185 |
| 3 | Modular cable | XCS-4 | 0730178 |
| 4 | Flash prommer box sales pack | FPS-8 | 0080321 |
| 5 | Printer cable | AXP-8, incl in FPS-8 sales pack | |
| 6 | D9 – D9 cable | AXS-4, incl in FPS-8 sales pack | 0730090 |
| 7 | Software protection key | PKD-1 | 0750018 |
| 8 | AC Charger, | incl in FPS-8 sales pack | 0680032 |
| 9 | SRAM Module (2 pcs needed inside FPS-8) | SF12 | 0080346 (Code includes one SRAM module) |

Figure 2: SRT-4 Opening Tool, upper part

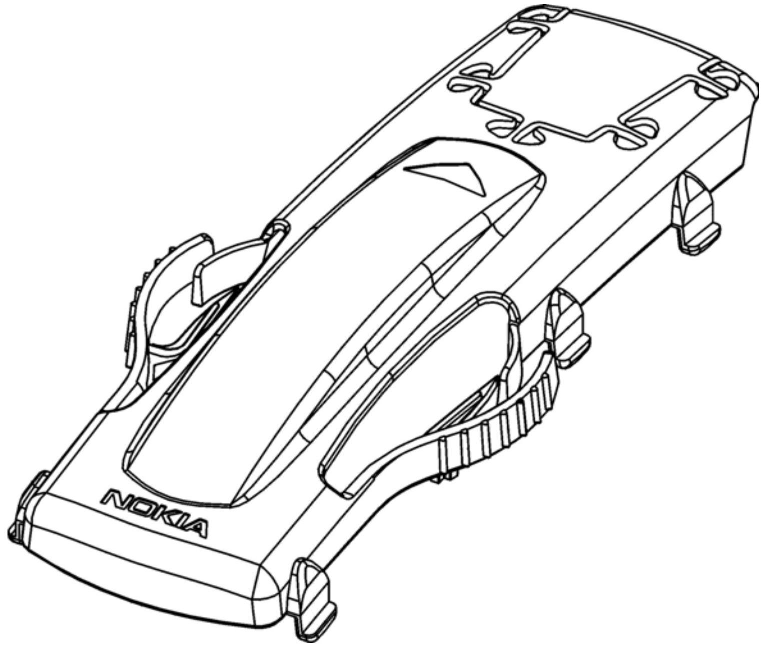
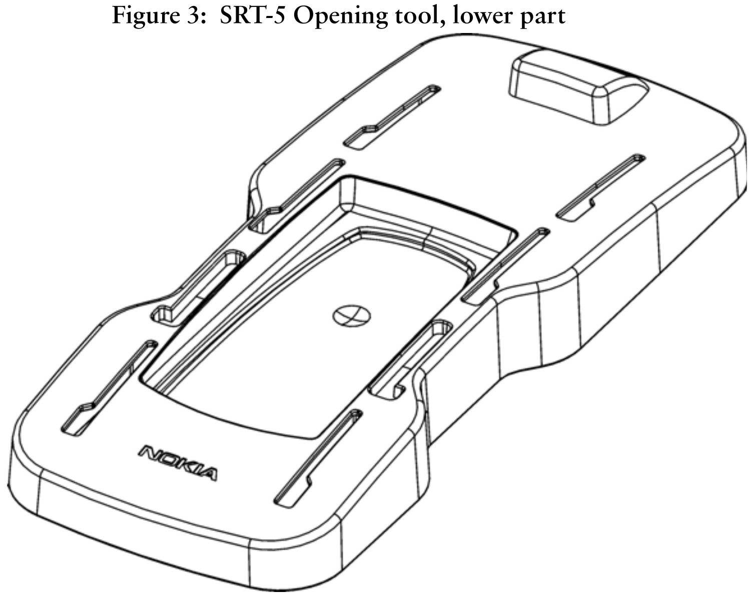



Figure 3: SRT-5 Opening tool, lower part




| Item | Description | Type | Code |
|---|---|---|---|
| fig. 2 | Opening Tool | SRT-4 | 0770286 |
| fig. 3 | Opening Tool | SRT-5 | 0770444 |

# Flashing Instructions

## Connecting phone to Service accessories

The purpose of this document is to guide you through NHL-2NA SW update in case you have set up the FPS-8 or FLS-4S SW update place according to instructions in previous chapters.

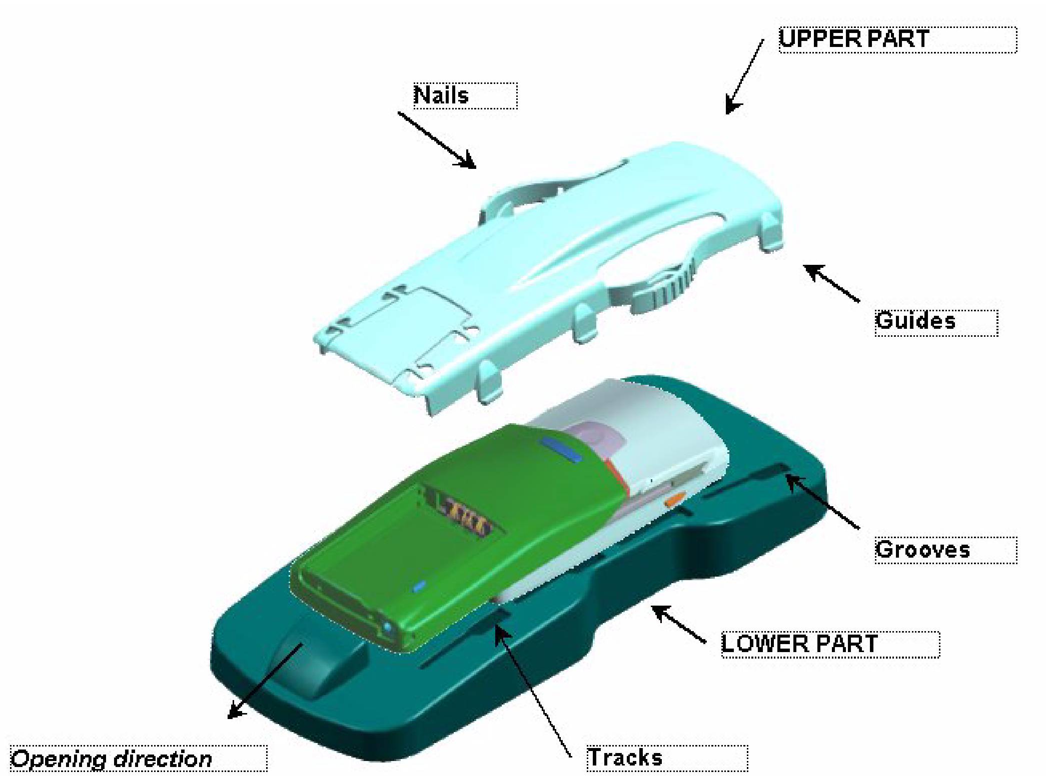
## Opening phone for SW update

Nokia 7650 does not have any external data connectors and mechanical solution limits the number lines between keyboard part and transceiver part. To get access to FBUS and MBUS flash connectors Nokia 7650 must be opened with special tools called SRT-4 and STR-5.

Opening procedure is as follows:

7 Place the phone grip opened onto lower tool cavity upside down.
8 Install upper part on the lower part so that the nails are in the phone tracks.
9 At the same time put the upper part guides to the lower part grooves.
10 Push the upper part till end of the grooves.
11 Push the upper part back to the starting point.
12 Remove the upper part.
13 Take the phone out of the tool.

**Figure 4: Instructions for use of STR-4 and SRT-5 opener.**



After this you should be able to see FBUS and MBUS pads as follows:

**Figure 5: FBUS and MBUS pads visible when Phone has been opened to service position.**


Once you have phone open like this, you can connect it to FLA-21 POS flash adapter. Some precautions should be taken as phone is not in standard use position:

*Warnings:*

*Warning 1. Do not detach the grip part totally from transceiver part if you have not been trained for that. Parts are interconnected with flex foil which can be damaged and after that phone can be repaired only with special tools.*

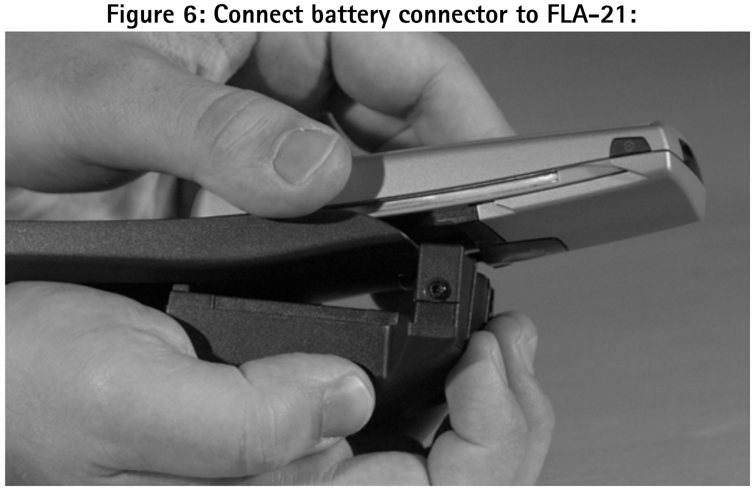
*Warning 2. If the grip part jumps slightly out of tracks when you are opening the phone, gently snap grip part back on its place.*

## Connecting phone to FLA-21 adapter

The following pictures show you the correct way to connect Nokia 7650 Phone to FLA-21 POS flash adapter.

1 First connect battery connector to FLA-21.

**Figure 6: Connect battery connector to FLA-21:**



2 Snap FLA-21 and Nokia 7650 together so that plastic nails in FLA-21 go into tracks in Nokia 7650.

**Figure 7: Connecting FLA-21 to Nokia 7650 so that plastic nails attach firmly into tracks.**

3 Connect rest of the cables for FLS-4S or FPS-8 SW update as illustrated earlier.

## SW updating

*IMPORTANT! Nokia 7650 will most likely have two kinds of data packages.*

1 SW releases which have only minor modifications in user data area. These packages do not format user data area. For this reason the user does not need to be read out from the device and does not need to be written back.

2 SW releases which have modifications in user data area. If this kind of SW release needs to be done, it will be clearly indicated in the Technical bulletin and Service bulletin that this package will automatically format user data. With this kind of SW release it is mandatory to backup all user data before SW update and restore it back to customers device after SW update.

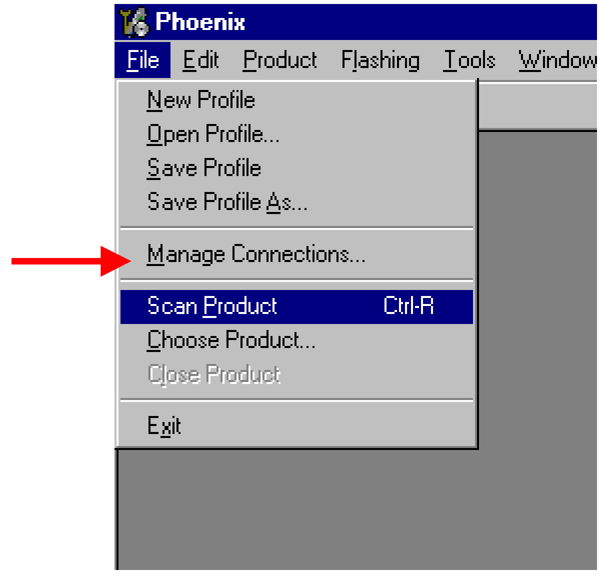
## Steps through SW update

Start now Phoenix SW by double clicking **Phoenix icon** on your desktop.

*Note! These instructions assume that you have configured buses from Manage Connections menu as advised earlier in this service manual. From Manager connections you can select the correct connection for the Flashadaper FLS-4S or FPS-8.*

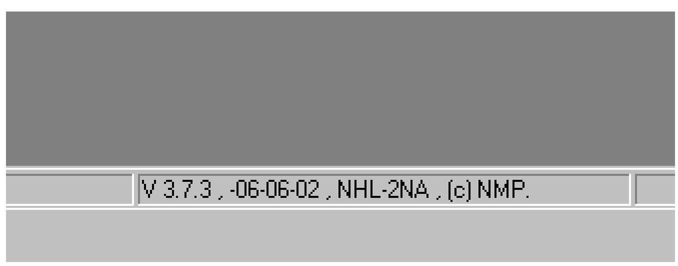
SW starts and shows you 'no product' text in the bottom of the screen. Product needs now to be scanned by choosing File -> Scan product as shown below:

Figure 8: Scanning product with phoenix




If scanning is successful, you will see 'no procut in the bottom of the screen to change into ENOS SW version inside the phone. See below:

Figure 9: Phone replied correctly to Product scan



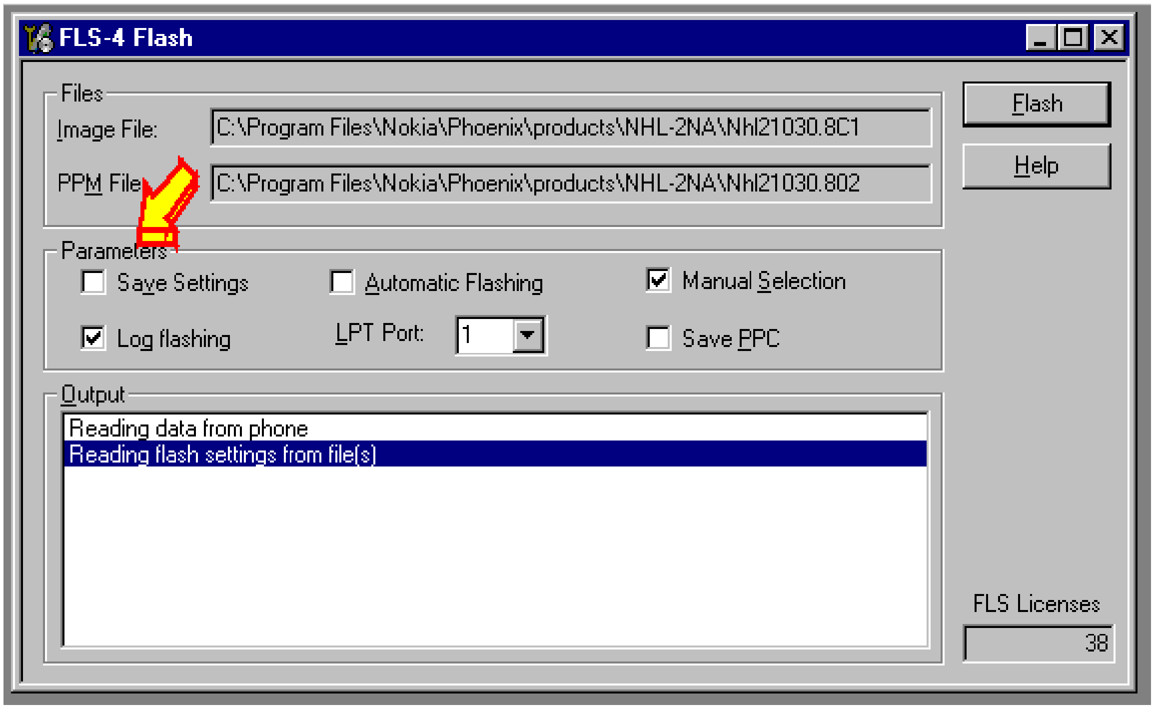

As phone is now correctly connected to FLS-4S or FPS-8 and scanning was successful, You can start SW update from **Flashing** menu.

Choose **Flashing** -> **FLS-4 Flash** (If you are using FLS-4S)

Choose **Flashing** -> **FPS-8** Flash (If you are using FPS-8)

The following window will open:

**Figure 10: Choosing correct files for SW update and marking Save settings box if necessary**




Phoenix SW now automatically reads the Product code which is stored electronically inside the phone and picks the files which are associated to this product.

*IMPORTANT:*

*Depending on weather the data package you have received automatically erases the user area or not, you have to check save settings box correctly. Otherwise all customer user data will be lost. Automatic erasing will be clearly stated tin the technical bulletin of the SW if this kind of SW will be published.*

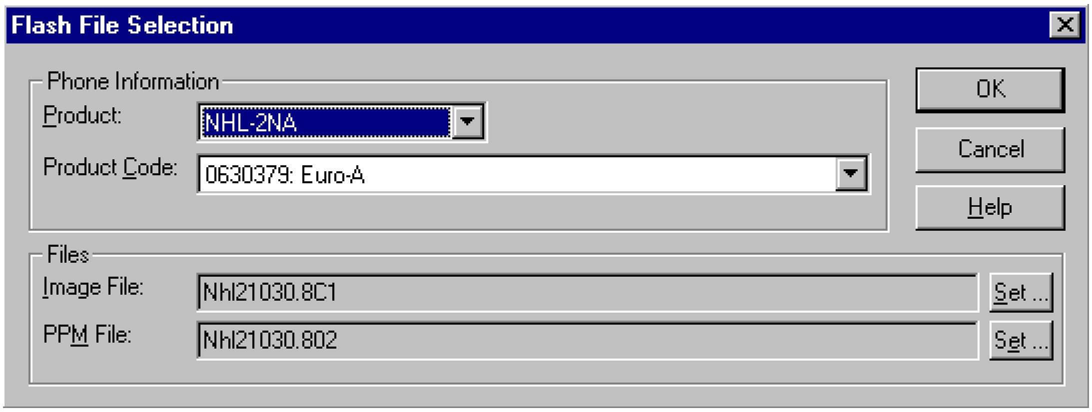
*If Technical bulletin says that used data area is not automatically formatted, do not mark Save settings box.*

*If Technical bulletin says that data package automatically formats user area, you must mark 'Save Settings' box.*

*Note: What is user area format? We have thought on behalf of you when user area format must be used when updating SW. If data package automatically formats user area it is clearly stated in the release note of the SW. User area format removes all user generated data from the phone. If data package automatically formats user data, you must save the User data before SW update.*

Choose now Flash and you will see the following dialogue box

Figure 11: Choosing the correct product code




Usually the electronic product code inside the device gives you the correct files to update into the phone. There is one exception to this rule. Exchange units can be updated with other SW than the one mentioned in the product code field.

Alternatives:

- In normal customer SW update case just press **OK** and SW update starts.
- In case you are updating the exchange unit to give it to the customer, choose from the product code list the variant customer has. It has to be the same which was in the original device of the customer. See Appendix in the end for this document for further info in Exchanging customers phone.

If you chose to save settings you will see the following windows as all customer settings and all user data is saved.

Figure 12: Saving settings progress bar.

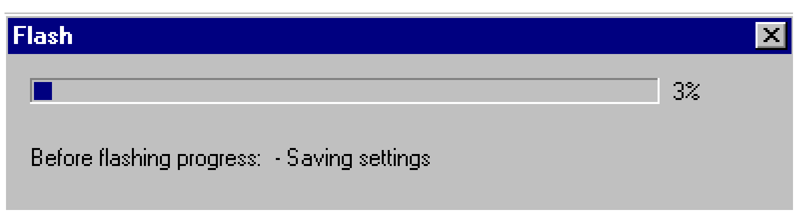
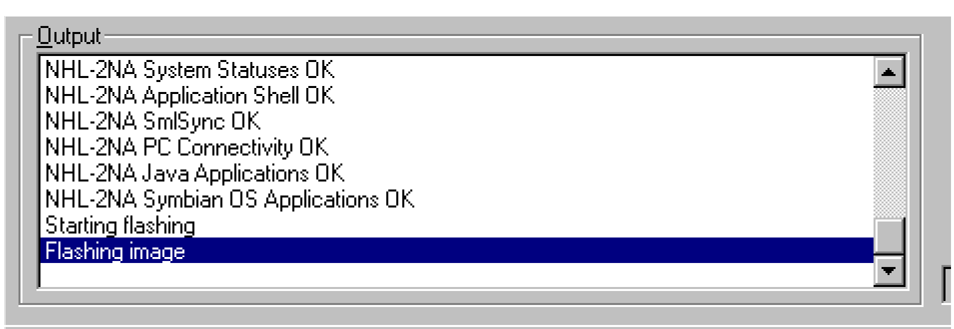
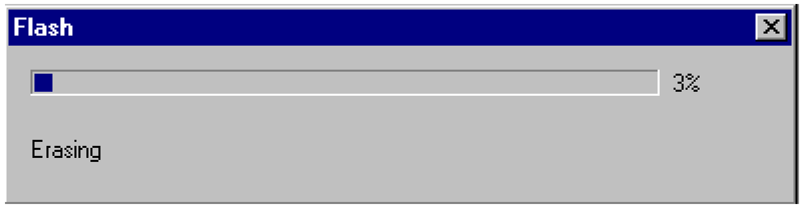



Figure 13: Window where you can see that all used data has been successfully saved.



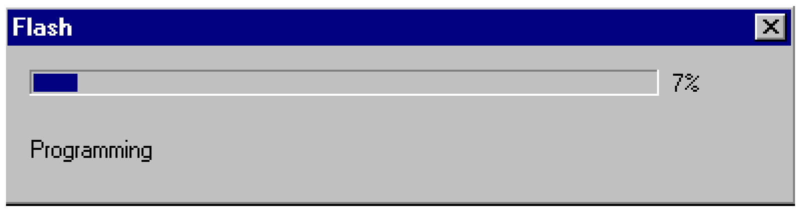
When SW update starts, you can see as Phoenix erases Core package memory area:

Figure 14: Phoenix erasing phone memory




And after this you can see as Phoenix programs new SW package into the phone.

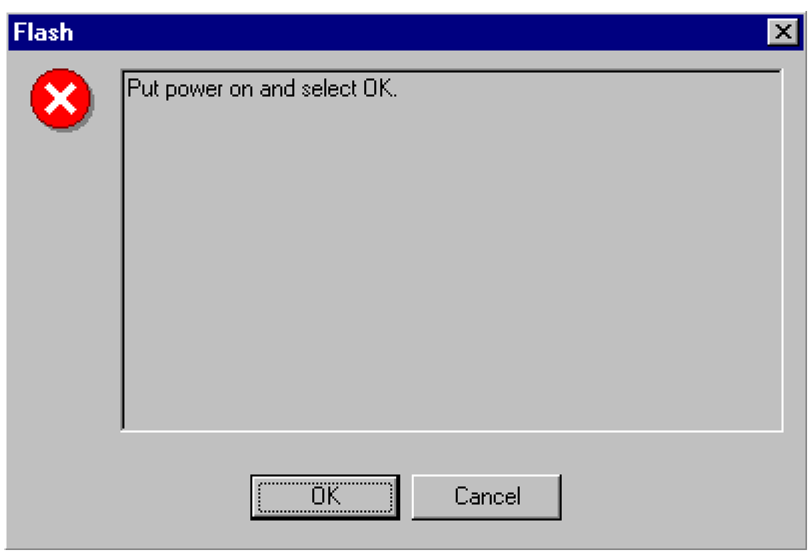
Figure 15: Phoenix programming phone memory




You will see two erases and two programmings as first core package area is erased and programmed and then language package area is erased and programmed.

Programming has ended when you see the following dialogue:

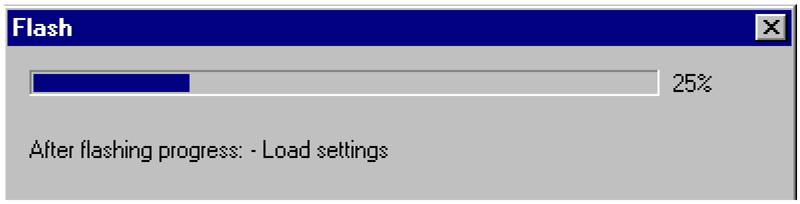
Figure 16: End of programming dialogue.




Now **press phone's power key** and wait until you see 'insert sim card' - text on the phones screen. Click **OK** with mouse. You will see some final operations in Phoenix window rolling on the screen

If you clicked on save settings box when you started SW update, you will now in this stage see as all user settings and all used data is loaded back to phone:

Figure 17: Loading all user settings and all user data back to phone

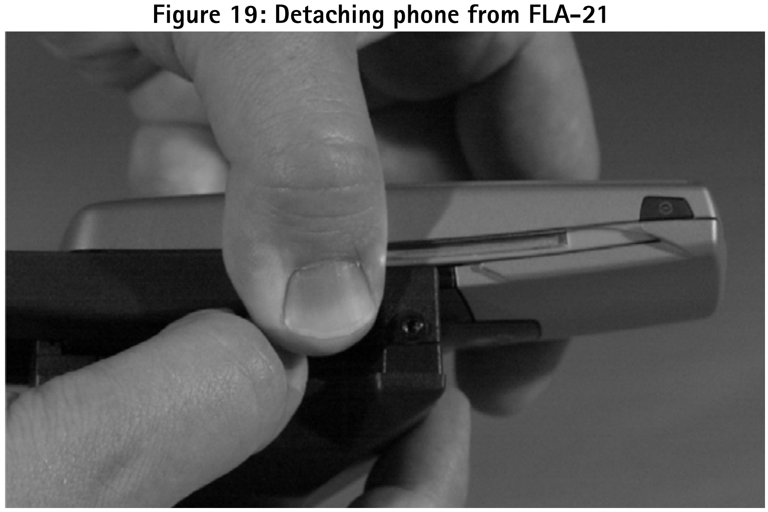



And finally when all files have been loaded back to phone, the following dialogue box appears:

Figure 18: SW update completed successfully.


Press now ok, wait until scrolling on the screen stops and detach you phone from FLA-21 as follows:

Figure 19: Detaching phone from FLA-21



Close now the phone into normal use position and insert SIM card and battery. Boot the phone up and see that all the user data has been restored correctly and check the SW version by typing *#0000# on the telephone application.

## Appendix A, Exchanging (Swapping) customers phone

In case customer's phone is so badly damaged that you have to give him/her exchange unit, the following instructions should be followed.

### Checking and updating exchange unit

Take exchange unit from its package and see which SW and language version it has. If it does not match the customers phone or SW version inside it is older than the newest one available, update it to the news SW available and update it with the language version which is identical with customers phone. Choose language from product code filed as illustrated in *Fig 7.* earlier in this document.

### Reading data from customers phone

Now take customers phone and try to read user data out from it if possible. Use of Phoenix recommended. PC suite can also be used but PC suite does not take backup of Midi ringing tone and java applications. In case customer has those in phone they will be lost during the operations.

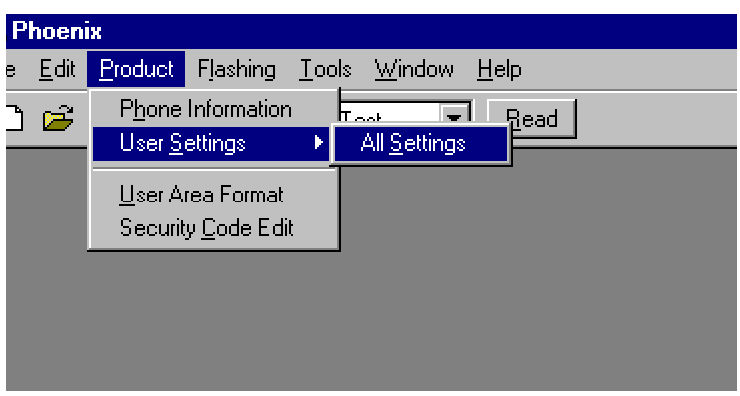
This document describes exchanging only with Phoenix SW.

Reading data from customers phone

Connect customers phone to FLA-21 and phoenix as described earlier in this document.

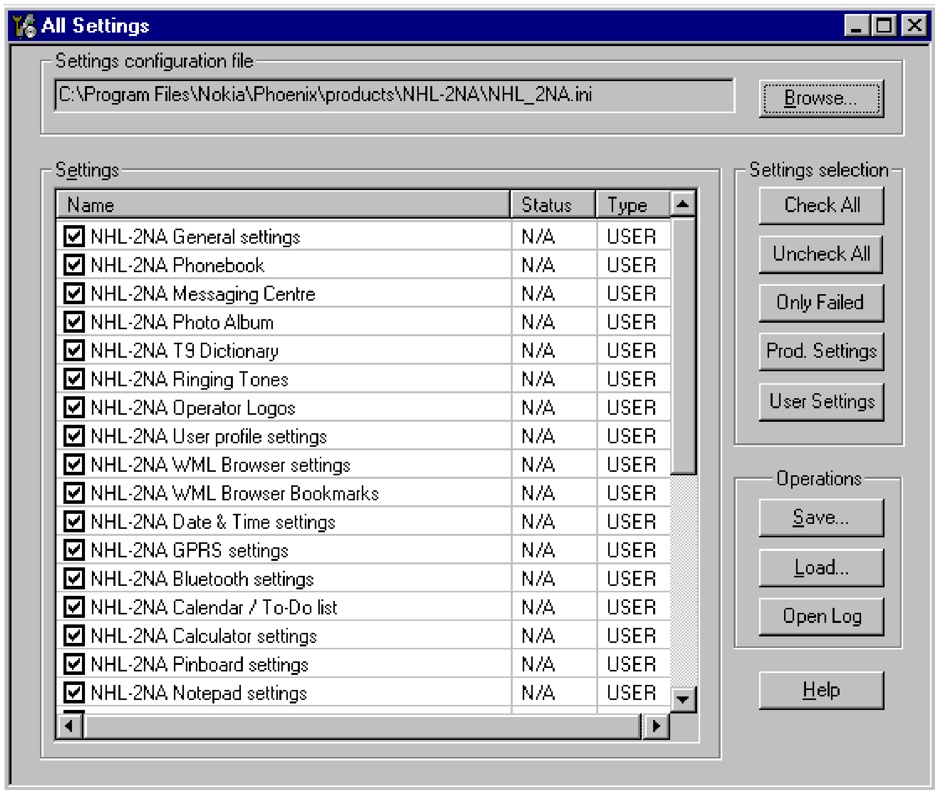
Scan the product and choose **Product** -> **user settings** -> **All settings** as follows:

**Figure 20: Saving user settings from customers phone when exchanging the unit.**




The following dialogue will open:

Fig 17. Saving customers settings and used data when exchanging unit.




All data is selected by default.

*Note! Maximum amount of data in Nokia 7650 is 4 Mbytes and exchange transfer is quite slow. It is advisable to ask customer to empty any unnecessary files from his/hers device before the exchange is started to speed up the process.*

Now press '**Save**' button and all data in the customers data is saved to PC hard disk.

When operation has finished, all status field go to OK status and you get the following note:

**Figure 21: All user data from customers defective device has been successfully saved to PC hard disk**

Now detach defective device from FLA-21 and attach exchange unit with newest SW and correct language version.

Choose **File** -> **Close product** and then **File -> Scan product.**

Choose **User settings -> all settings** as in *figures 16 and 17.*

Now choose Load and load all the data you just red from the defective device to the exchange unit.

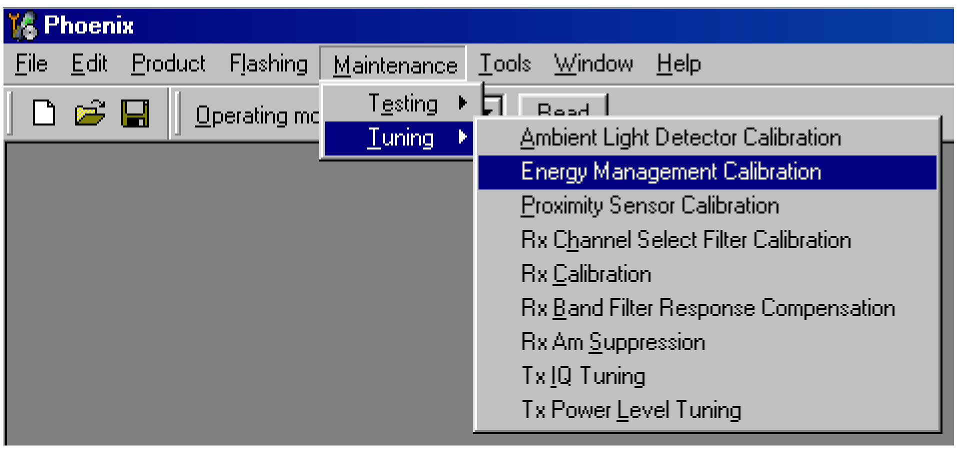
When the operation is complete, detach the phone from FLA-21, boot it up with SIM card and battery and see that SW version is the newest one and that all customer data has been correctly restored.

# Energy Management Calibration

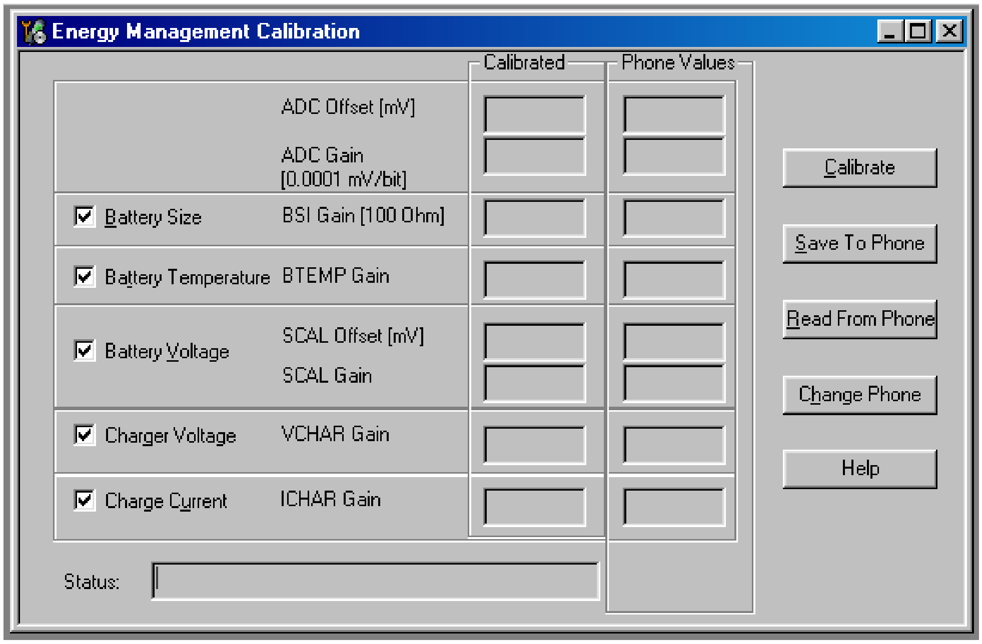
## Baseband Tunings

### Energy Management Tuning

- External power supply needed
- EM Calibration is used for calibrating Battery and Charger settings of the phone.
- Preparation for EM Calibration:
  - Connect DC Cable SCB-3 between JBV-1 and Vin of Phone for Charger calibration.
  - Connect 12...15 V from Power Supply to JBV-1.
  - NOTE! Check that connection is F-BUS (doesn't work with M-BUS!).
- Select Maintenance => Tuning => Energy Management Calibration




- Energy Management values to be calibrated are checked
- Select “Read from Phone” to show current values in phone memory and to check that the communication with phone works
- Select “Calibrate” to run selected calibrations




Limits for Energy Management Calibration:

| | **Min** | **Max** |
|---|---|---|
| ADC gain | 25400 | 29000 |
| DC offset | -50 | 50 |
| BSI gain | 860 | 1180 |
| BTEMP gain | 1980 | 2450 |
| VBAT gain | 10000 | 11000 |
| VBAT offset | 2300 | 2700 |
| VCHAR | 58000 | 62000 |
| ICHAR | 4000 | 4800 |

- If values shown are within limits select “Save To Phone” to save values to phone.
- NOTE! Only values of checked tunings (Battery size, Battery Temperature etc....) will be saved.
- Close the “Energy Management Calibration” – dialog to end tuning

# Sensor calibration instructions

## Proximity Detector Calibration

### General

Three parameters are calibrated in proximity sensor calibration: Gain, Detection threshold and Fault detection threshold. Calibration must be done always when emitter, receiver, AEM or proximity optics have been replaced.

Calibration is done in two phases. First detection threshold and gain are calibrated. If this is done successfully, fault detection threshold is calibrated.

Start values for calibration are defined by NMP. Using correct start values is necessary for successful calibration. At Nokia Mobile Phone's request, Start values can be changed by editing nhl2pxm.ini file in \Phoenix\Products directory. Start values in nhl2pxm.ini can be taken into use by pressing Use defaults-button.

**Tools**

- MJF-7 with 20% diffuse reflectance target.

*Note: In troubleshooting purposes the calibration can be done also in other test jigs and without standard target, but those calibrations never replace calibration with MJF-7.*

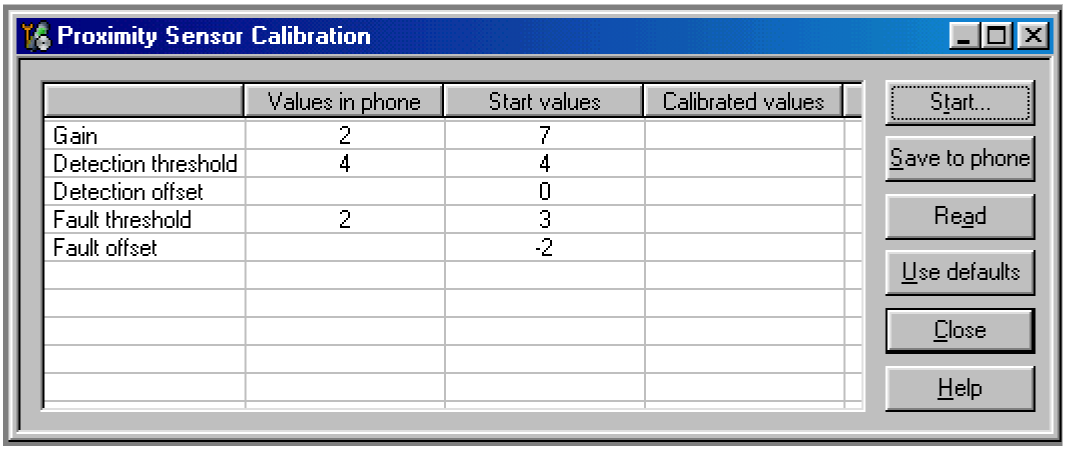
- Phoenix with 'Proximity Sensor Calibration'-tool.
- The figure below shows the correct setup for proximity detector calibration.

Figure 1: Proximity Detector Calibration Setup

**Calibration**

- Start 'Proximity Sensor Calibration'-tool: Maintenance -> Tuning -> Proximity Sensor Calibration. Values in the phone permanent memory are read automatically from phone memory, when calibration tool is started.

Figure 2: Proximity Sensor Calibration dialog with start values




The Proximity Detector Calibration Setup figure shows the Proximity Sensor Calibration tool. Gain, Detection threshold, and Fault threshold in the left column are the values in phone permanent memory. Middle column shows start values that are used in the calibration. They are defined by Nokia Mobile Phones, and should not be changed without Nokia Mobile Phones request.

*Note! Values in the Figure 2 are not correct after 06/2002.*

- Default start values (06/2002) are Gain 7, Detection threshold 4, Detection offset 1, Fault threshold 3 and Fault offset –2.

- Press Start to start the calibration, and follow instructions. At first Phoenix ask you to place the reflectance target above the proximity lenses. Calibration may be done only with 20% reflectance target (size 50mm*50mm, distance from the lenses 50mm). Use only Nokia accepted calibration target that is provided with MJF-7.

- After successful detection/gain calibration Phoenix asks you to remove the calibration target for fault detection threshold calibration. Make sure, that there is at least 1500mm free space above the phone.

- If something has gone wrong in the calibration, return message gives valuable information for error hunting. From Help menu you can find some indication of the fault, more detailed information is found in the baseband troubleshooting document. In the figure Error message after failed calibration you can see the error message after failed fault threshold calibration, it is FAULT_OVER_LIMIT.

- Message after successful calibration is in the figure Return message when calibration was successful.

Figure 3: Error message after failed calibration

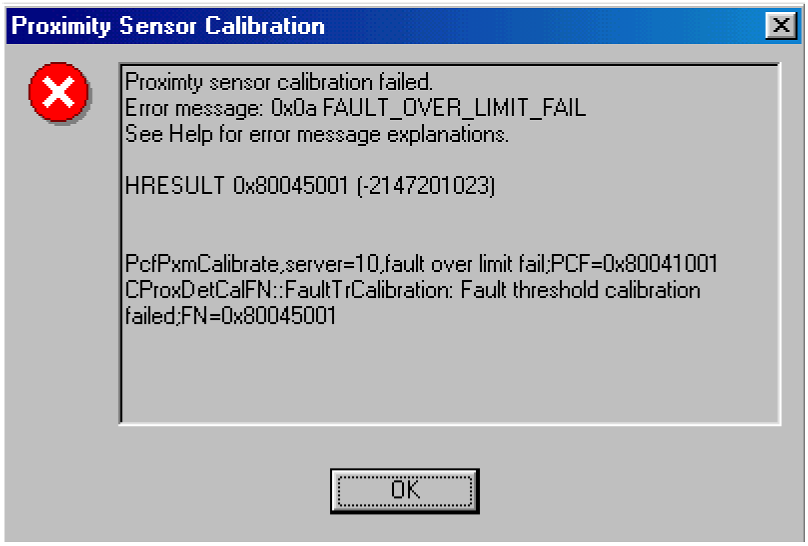
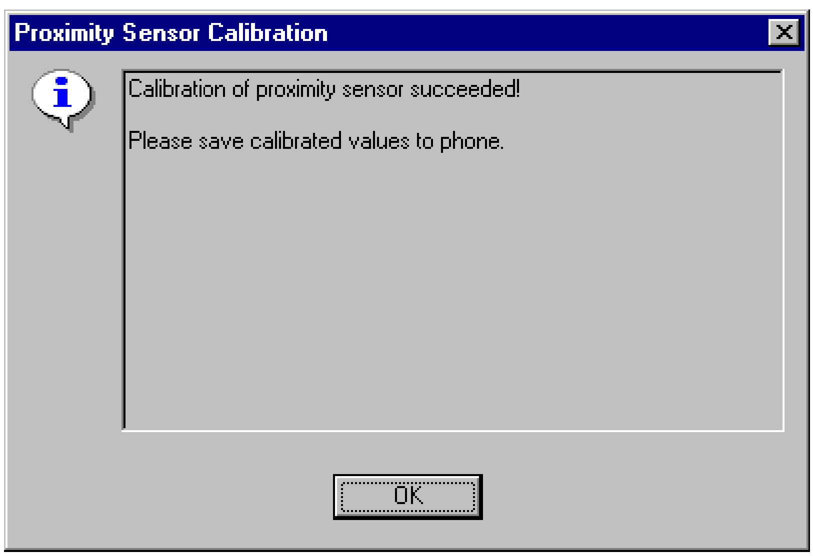
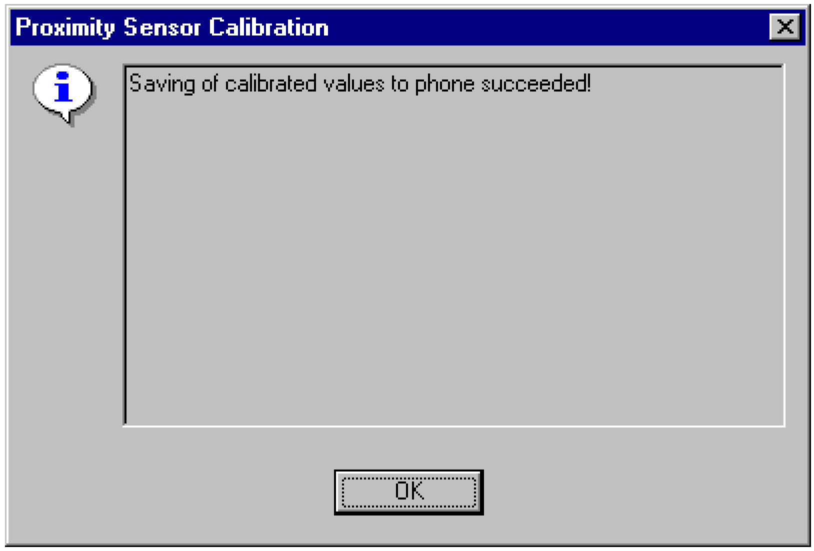



Figure 4: Return message, when calibration was successful




- Calibration result is shown in the right column of Proximity Sensor Calibration dialog (Figure Proximity Sensor Calibration dialog with start values). Press 'Save to phone' to save calibration result. After successful saving of calibrated values, you get the message in Figure Return message after successful saving of calibration result. With 'Read' button you can double-check that saving the values has succeeded. Note that offset values defined in the middle column are now added to the detection threshold and fault detection threshold.

Figure 5: Return message after successful saving of calibration result




## Ambient Light Detector Calibration

### General

Ambient Light Detector calibration is based on comparison between reference value and ADC-reading from the calibrated phone. Calibration is done by illuminating the phone with a white LED light source, TDS-11. Reference value is read from a Golden Phone.

Reading reference value with a Golden Phone is called System Calibration. Most important for successful calibration is, that System Calibration is done in the same lightning conditions, where calibration is done. To make sure, that lighting conditions are identical, calibration must be done in darkness. This can be achieved for example by covering MJF-7 and TDS-11 with a cardboard box.

Only if the Golden Phone is not available, a default reference value that is provided with TDS-11 can be used.

### Tools

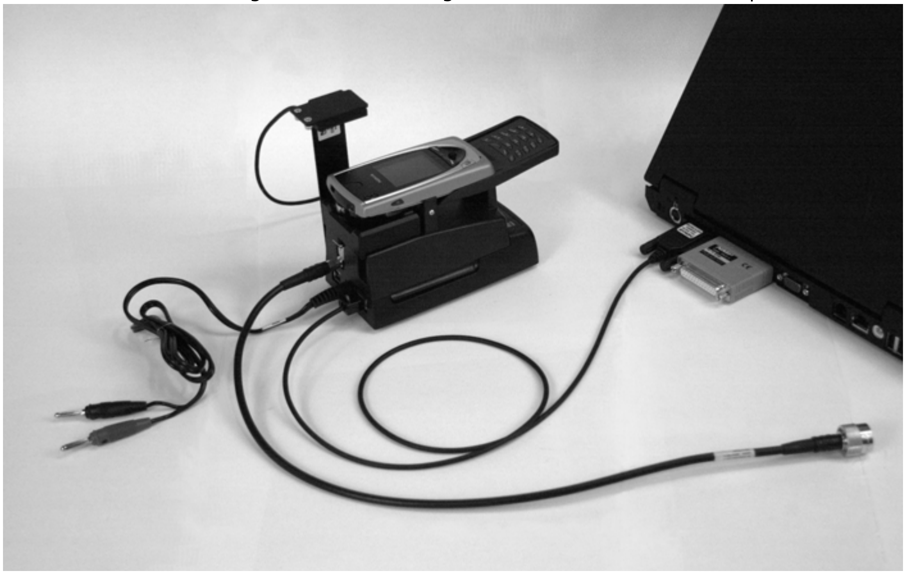
- MJF-7 with white LED light source (TDS-11 Calibration lamp, 0770440).

*Note that the supply voltage to JBV-1 has to be precisely 14.0 Volts. This has effect on TDS-11 brightness despite the 12 V regulation in TDS-11 output.*

- Phoenix with 'Ambient Light Detector Calibration'-tool. Picture of calibration tool is in the figure Ambient Light Detector Calibration Dialog.

- The Figure 7 Ambient Light Detector Calibration Setup shows the Ambient Light Detector Calibration Setup.

Figure 6: Ambient Light Detector Calibration Setup



## System Calibration

System calibration must be done always, when:

- Calibration light source has been changed
- After ~1000 calibrations or once a month

System calibration is done with a Golden Phone provided by NMP. Only if the Golden Phone is not available, default reference value provided with TDS-11 can be used.

- 'Start Reference Value' tells the reference value that has been read from a Golden Phone. System calibration changes this value, and it needs to be done if lighting conditions have changed. When you are doing the calibration for the first time, start reference is 0 and system calibration has to be done.

System calibration procedure is following.

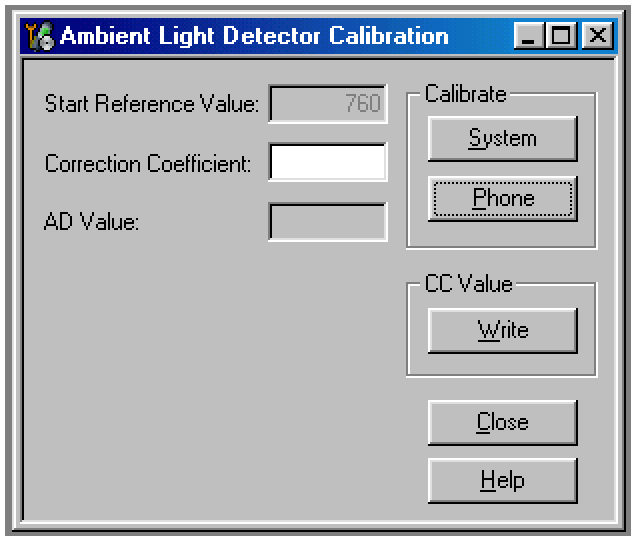
- Attach Golden Phone to the MJF-7.
- Start 'Ambient Light Detector Calibration'-tool: Maintenance -> Tuning -> Ambient Light Detector Calibration
- Press 'System Calibration' and follow instructions. Choose System Calibration with Golden Phone always, when Golden Phone is available.
- New reference value will be used until next System Calibration. Calibration lightning conditions may not change after this.
- Only if Golden Phone is not available, choose 'Change Reference Value manually'. Then enter the default reference value that is provided with TDS-11 light source.

## Calibration

- Save calibration values from phones permanent memory before starting calibration.

- Start 'Ambient Light Detector Calibration'-tool: Maintenance -> Tuning -> Ambient Light Detector Calibration.

Figure 7: Ambient Light Detector Calibration Dialog




- Place calibrated phone to the MJF-7 and press 'Phone'. If the calibration was successful, calibrated value is shown in the middle box 'Correction Coefficient'. Press 'Write' to save the value to the phone. AD value in the lowest edit box is just for your information.

- CC is 1, if calibrated phone behaves exactly like the Golden Phone. Normally the value is between 0.75 and 1.25. If value is not between 0 and 8, you will get an error message.

# RF-Tuning Instructions (with Phoenix)

## General

RF tunings should be made in the same order as shown in this section.

If baseband tunings are needed, they should be made before the RF tunings

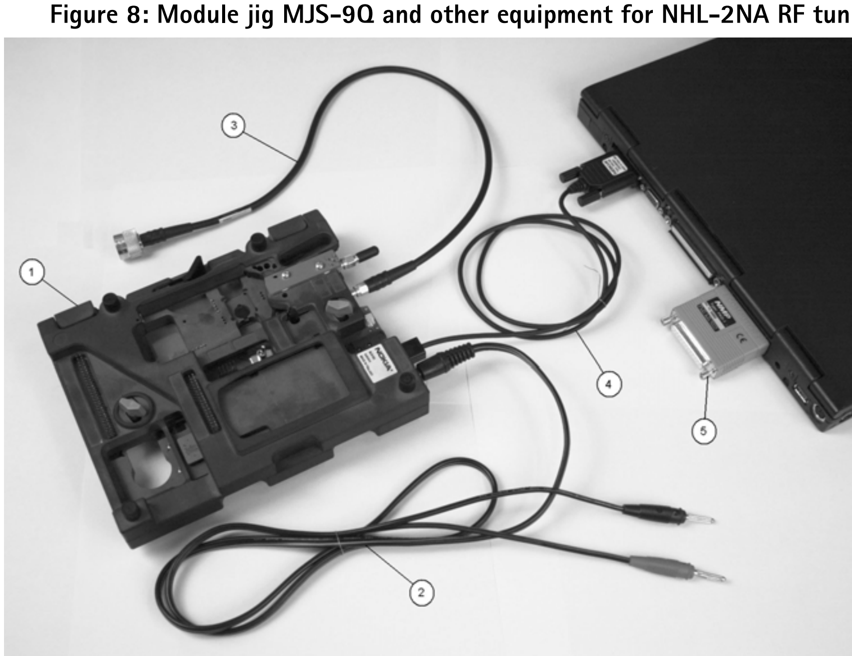
Avoid unnecessary tuning – factory tuning values are always the most accurate ones.

Views in this document may change as the service software is developed. Please refer to the Phoenix help files, phone model specific service manual and bulletins for help.

## Service Tool Concept for RF Tunings

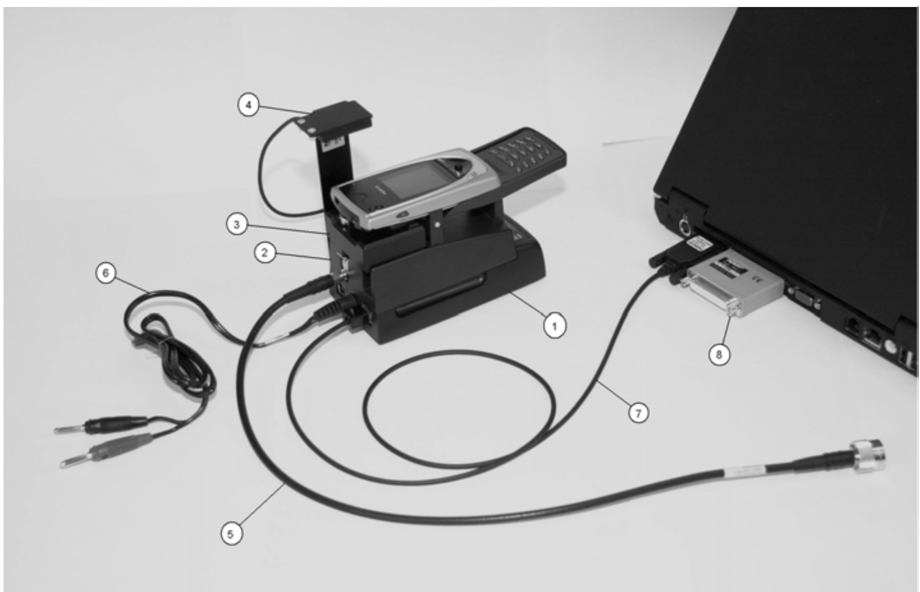
- All RF tunings should be carried out using in MJS-9Q (module jig), TDS-10 (RF-probe) or RA-7 (RF-adapter)
- CPL-5 coupler can only be used for testing, NOT for tuning!
- Power to MJS-9Q or to JBV-1 should be supplied from an external DC power supply, not FPS-8 prommer
- MJS-9Q maximum input voltage is +9 V DC, nominal input for RF tunings is +6V DC
- TDS-10 and RA7 needs MJF-7 (docking station adapter) in JBV-1 (docking station). JBV-1 input voltage is +14 V DC
- Remember cable and jig attenuations when setting required RF levels

**Figure 8: Module jig MJS-9Q and other equipment for NHL-2NA RF tuning.**



| Item: | Service accessory | | Product code |
|---|---|---|---|
| 1 | Module jig | MJS-9Q | 0775284 |
| 2 | DC power cable | PCS-1 | 0730012 |
| 3 | RF antenna cable | XRF-1 | 0730085 |
| 4 | Service MBUS cable | DAU-9S | 0730108 |
| 5 | Software protection key | PKD-1 | 0750018 |

**Figure 9: RF-connection TDS-10 and other equipment for NHL-2NA RF tuning**




| Item: | Service accessory | | Product code |
|---|---|---|---|
| 1 | JBV-1, Docking station | | 0770298 |
| 2 | MJF-7, Docking station adapter | | 0775285 |
| 3 | TDS-10 GSM RF Probe for RF tuning | | 0770436 |
| 4 | TDS-11 Calibration lamp | Not needed in RF-tuning | 0770440 |
| 5 | XRF-1, RF antenna cable | | 0730085 |
| 6 | PCS-1, DC power cable | | 0730012 |
| 7 | DAU-9S, Service MBUS cable | | 0730108 |
| 8 | PKD-1, Software protection key | | 0750018 |

*Note: RA7 can be used instead of TDS-10. RA7 replaces the antenna module, thus it's use requires opening 4 antenna screws in order to place RA7 to the phone.*

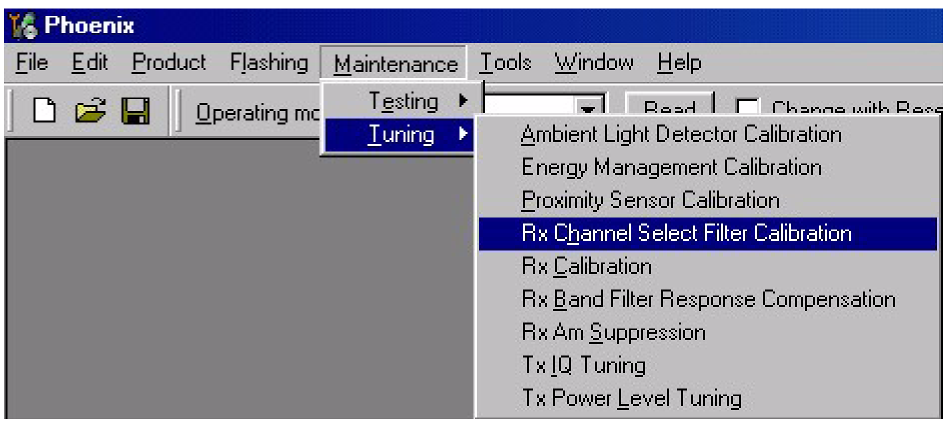
  

| Item: | Service accessory | | Product code |
|---|---|---|---|
| - | RF adapter for NHL-2NA | RA7 | 0770443 |

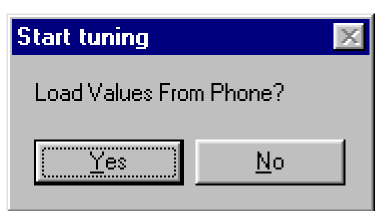
## Receiver tunings

### RX Channel Select Filter Calibration

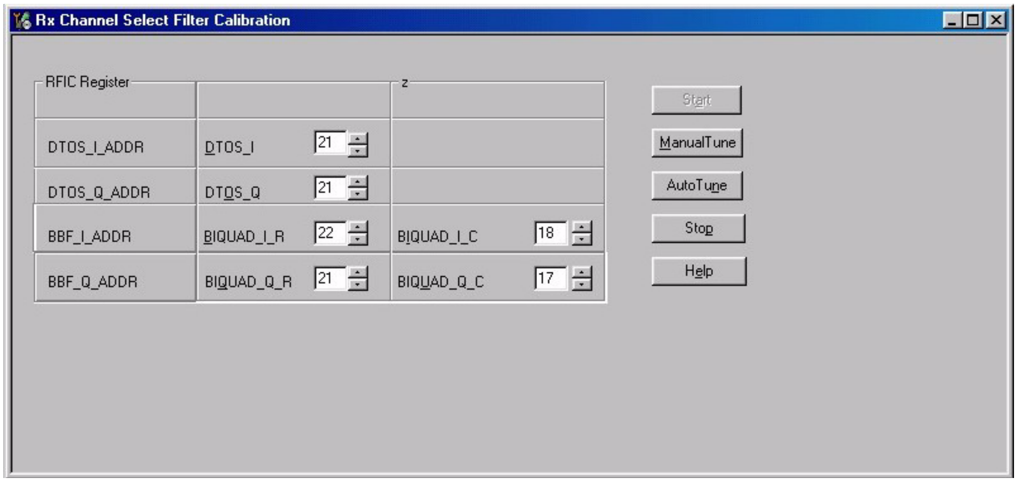
- Extra equipment / external RF signal not needed
- Must be done before other RX calibrations
- This function is used to calibrate RX channel select filter in GSM Phones.
- Rx Channel select filter is tuned only in one band = Single calibration for both bands
- Select Maintenance => Tuning => Rx Channel select filter calibration



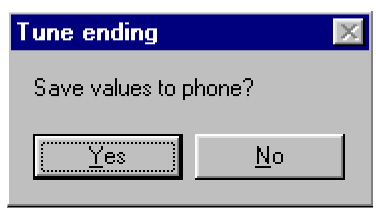

- Select “Yes” to start tuning with values already saved to the phone




- Press "AutoTune" to start the tuning



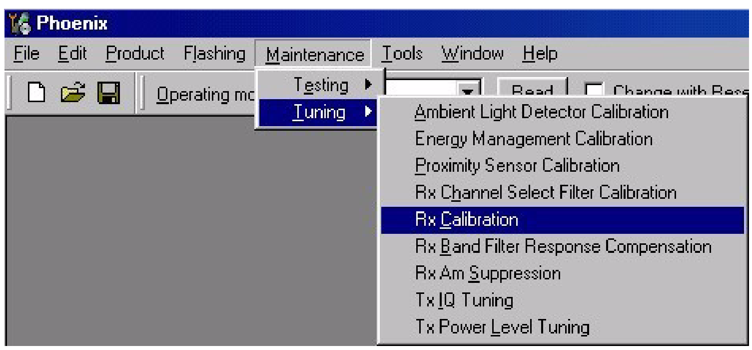

- Tuning values should be 0...31
- Select “Stop”
- If values shown are within limits, choose “Yes” to save values to the phone save them to phone.




- Close the “RX Channel Select Filter Calibration “– dialog to end tuning

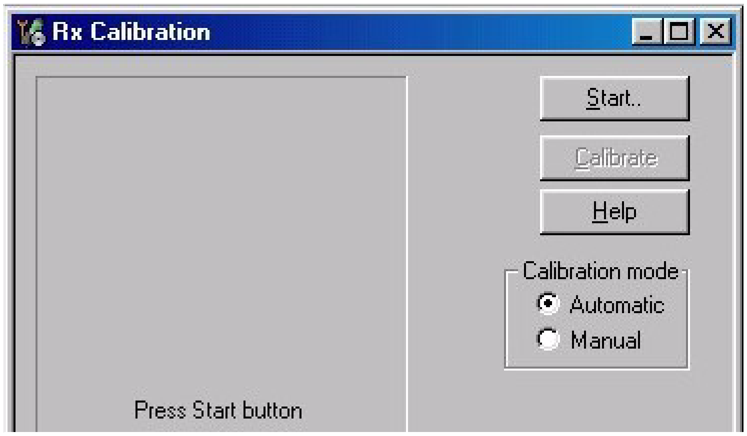
**RX Calibration**

- RF generator needed
- This tuning performs RX Calibration
- Must be done separately on both bands!
- Start RX Calibration at EGSM (GSM900), then do RX Calibration at GSM1800 band.
- AFC tuning is done while EGSM (GSM900) band RX Calibration is performed.
- *Remember to take jig and cable attenuations into account!*
- Select Maintenance => Tuning => Rx calibration

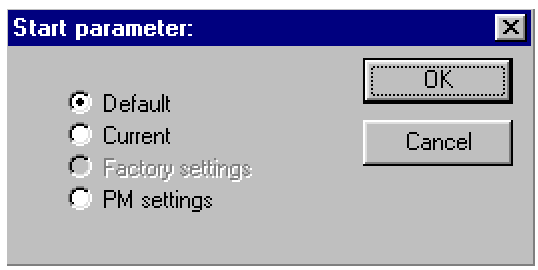



- When RX Calibration has been started, you can choose the correct band from the dropdown menu. Begin tuning from EGSM 900 band.

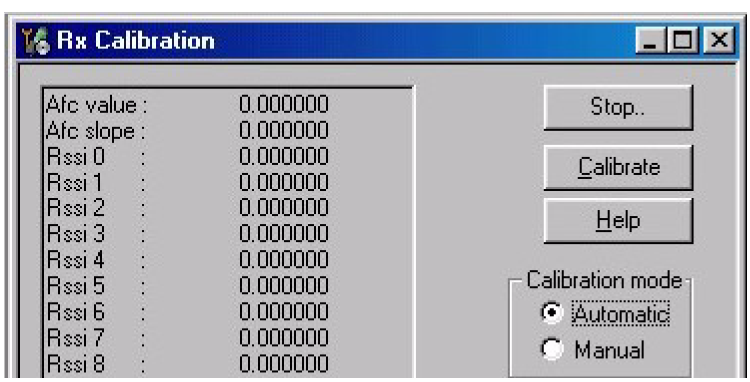

- Press "Start"



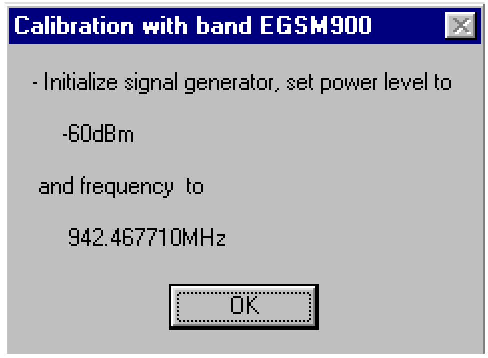

- Select “Default” to start tuning from factory default values => OK




- Set the Calibration mode to “Automatic”
- Press "Calibrate"




- Set RF generator to required frequency => OK

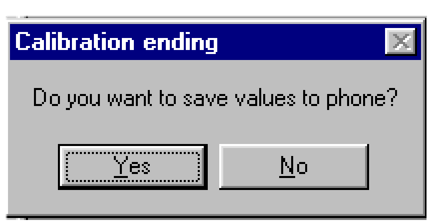



Tuning values and ADC readings will be shown

Typical values and limits in (GSM900) RX Calibration:

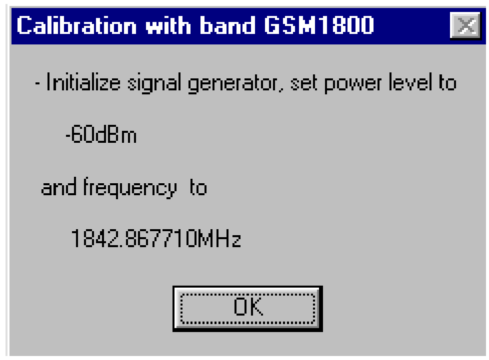
| **EGSM (GSM900)** | **Typical value** | **Limits** |
|---|---|---|
| AFC value | -176 | -350...+350 |
| AFC slope | 269 | 150...350 |
| RSSI0 | 74 | 67...77 |
| RSSI1 | 84 | 77...87 |
| RSSI2 | 94 | 87...97 |
| RSSI3 | 99.5 | 94...104 |
| RSSI4 | 109.5 | 104...114 |
| RSSI5 | 119.5 | 114...124 |
| RSSI6 | 129.5 | 124...134 |
| RSSI7 | 139.5 | 134...144 |
| RSSI8 | 149.5 | 144...152 |

- Choose “Stop” to end tuning
- If values shown are within limits, choose “Yes” to save values to the phone




- Continue tuning from GSM1800. Choose the correct band from the dropdown menu.
- Press "Start" to continue just like in the EGSM900 Band above.

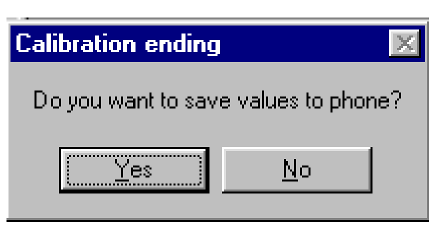

When asked, set RF generator to required frequency => OK




Typical values and limits in (GSM1800) RX Calibration:

| GSM1800 | Typical value | Limits |
|---|---|---|
| RSSI0 | 66.5 | 63...73 |
| RSSI1 | 76.5 | 73...83 |
| RSSI2 | 86.5 | 83...93 |
| RSSI3 | 99.5 | 94...104 |
| RSSI4 | 109.5 | 104...114 |
| RSSI5 | 119.5 | 114...124 |
| RSSI6 | 129.5 | 124...134 |
| RSSI7 | 139.5 | 134...144 |
| RSSI8 | 149.5 | 144...152.5 |

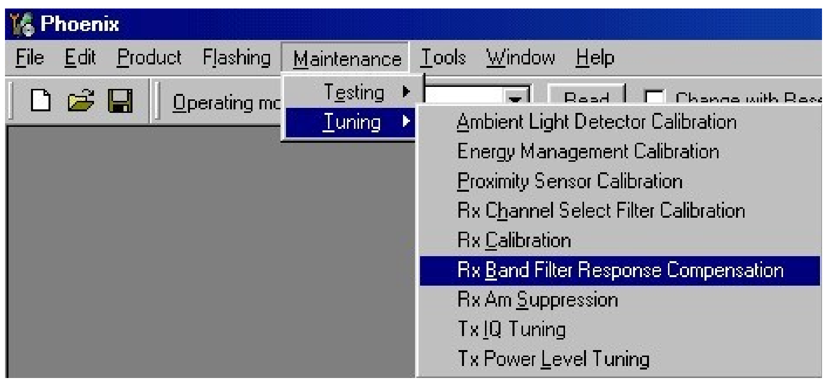
- Choose “Stop” to end tuning
- If values shown are within limits, choose “Yes” to save values to the phone



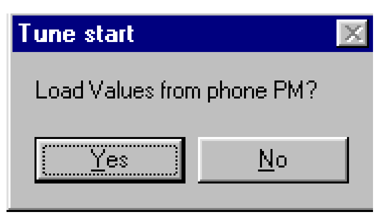
- Close the “RX – Calibration – dialog to end tuning

**RX Band Filter Response Compensation**

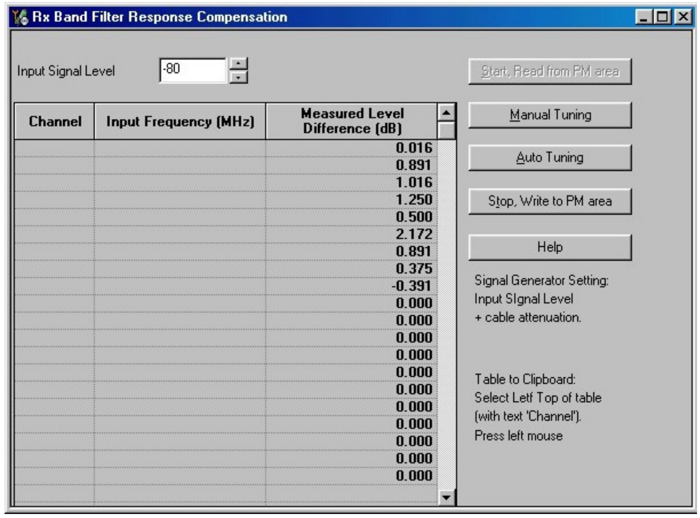
- RF generator needed
- Must be done separately on both bands!
- Start RX Band Filter Response Compensation at EGSM (GSM900), then do RX Band Filter Response Compensation at GSM1800 band.
- *Note: Remember to do RX calibration before doing Rx Band Filter Response Compensation!*
- Remember to take jig and cable attenuations into account!
- Select Maintenance => Tuning => Rx band filter response compensation



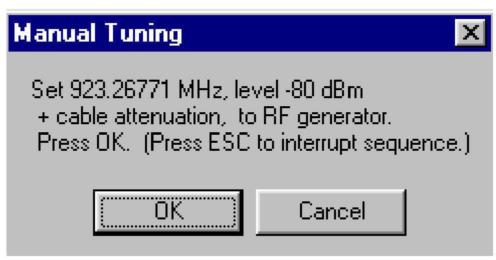

- Select “Yes” to start tuning with values already saved to the phone



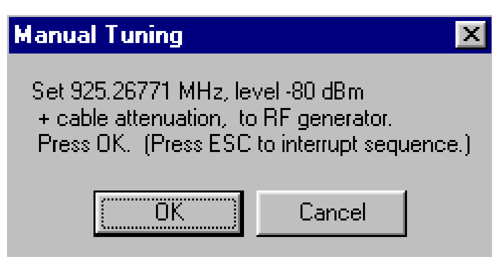

- Select "Manual tuning"



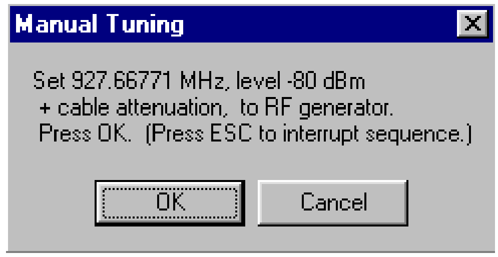

- You will be asked to supply 9 different RF frequencies to the phone
- Set first required frequency and level => OK



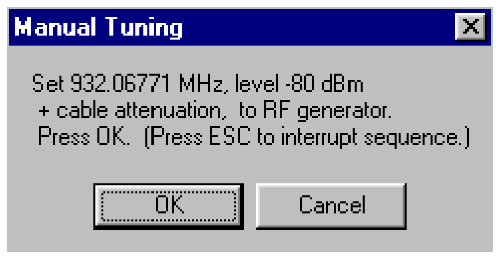

- Set 2nd required frequency and level => OK



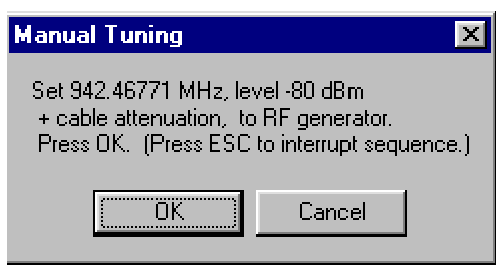

- Set 3rd required frequency and level => OK



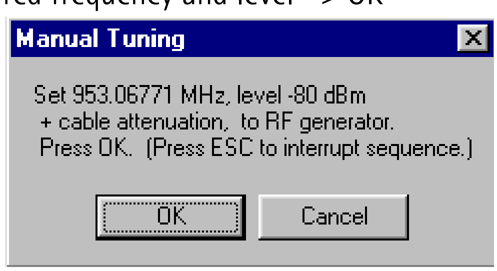

- Set 4th required frequency and level => OK



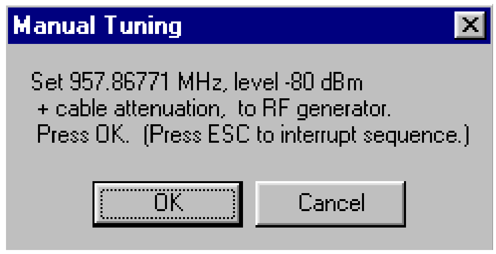

- Set 5th required frequency and level => OK



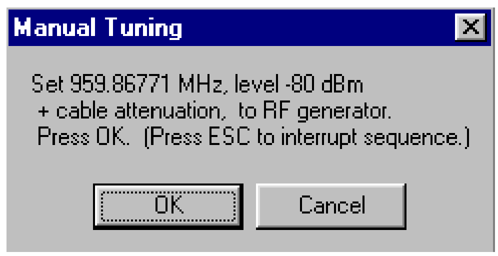

- Set 6th required frequency and level => OK



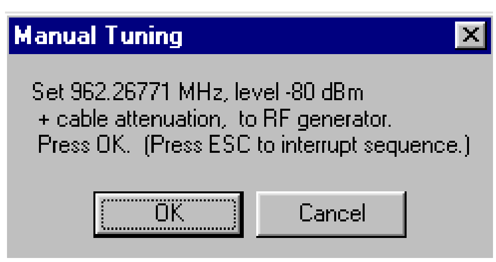

Set 7th required frequency and level => OK




Set 8th required frequency and level => OK




Set 9th required frequency and level => OK

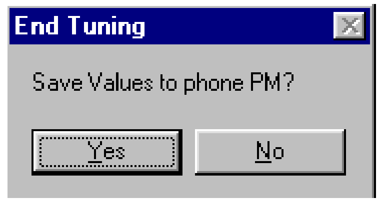



Typical values and limits in Rx Band Filter Response Compensation EGSM900:

| **Channel** | **Input frequency (MHz)** | **Measured level difference (dB)** | **Limits (dB)** |
|---|---|---|---|
| 965 | 923.26771 | -0.118 | -10...+5 |
| 975 | 925.26771 | 0.511 | -5...+5 |
| 987 | 927.66771 | 0.857 | -5...+5 |
| 1009 | 932.06771 | 1.174 | -5...+5 |
| 37 | 942.46771 | 0.569 | -5...+5 |
| 90 | 953.06771 | 1.928 | -5...+5 |
| 114 | 957.86771 | 0.964 | 5...+5 |
| 124 | 959.86771 | 0.545 | -5...+5 |
| 136 | 962.26771 | -0.040 | -10...+5 |

- Choose "Stop, write to PM area"

- If values shown are within limits, choose “Yes” to save values to the phone




**Continue tuning from GSM1800.** Choose the correct band from the dropdown menu.


- Repeat the same steps as for the EGSM900 band above

Typical values and limits in Rx Band Filter Response Compensation GSM1800:

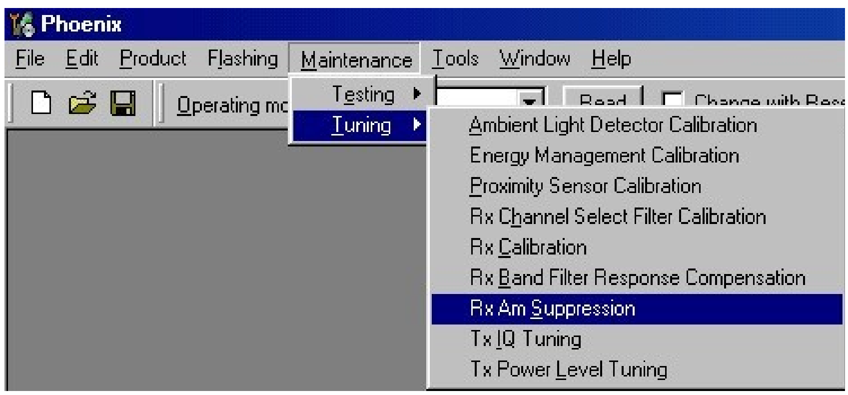
| **Channel** | **Input frequency (MHz)** | **Measured level difference (dB)** | **Limits (dB)** |
|---|---|---|---|
| 497 | 1802.26771 | 0.214 | -10...+5 |
| 512 | 1805.26771 | 1.739 | -5...+5 |
| 535 | 1809.86771 | 2.056 | -5...+5 |
| 606 | 1824.06771 | 1.632 | -5...+5 |
| 700 | 1842.86771 | 0.583 | -5...+5 |
| 791 | 1861.06771 | 0.734 | -5...+5 |
| 870 | 1876.86771 | 0.616 | -5...+5 |
| 885 | 1879.86771 | 0.185 | -5...+5 |
| 908 | 1884.46771 | -1.132 | -10...+5 |

- If values shown are within limits, save values to the phone

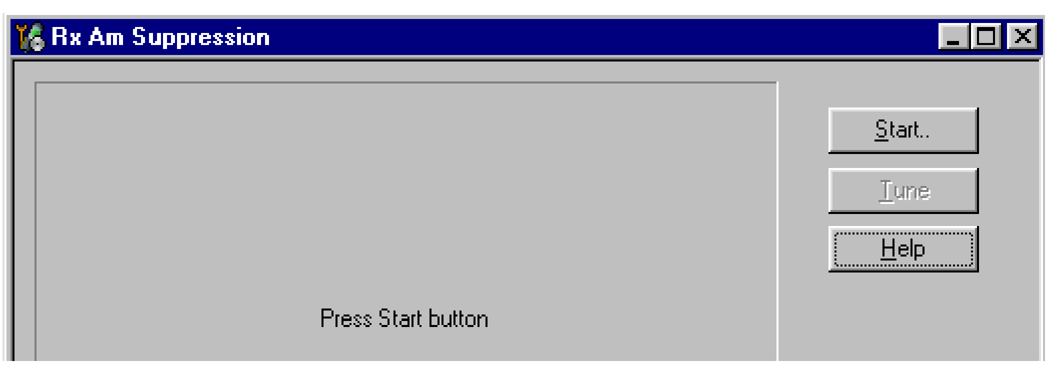
- Close the “RX Band Filter Response Compensation” – dialog to end tuning

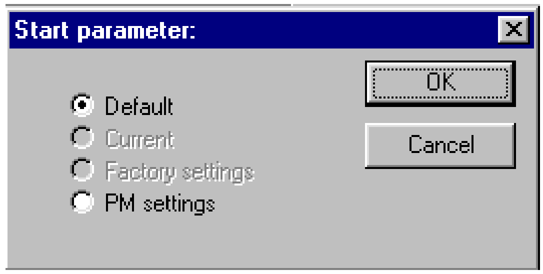
**RX AM Suppression**

- RF generator needed (AM modulation)
- Must be done separately on both bands!
- Start RX AM Suppression at EGSM (GSM900), then do RX AM Suppression at GSM1800 band.
- This dialog performs RX AM Suppression.
- Remember to take jig and cable attenuations into account!
- Select Maintenance => Tuning => Rx Am suppression

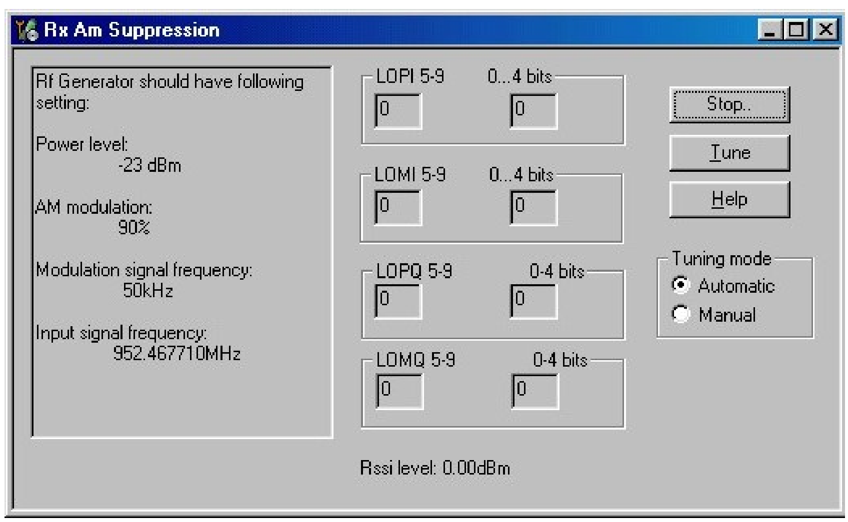



- Start => Default settings => OK,

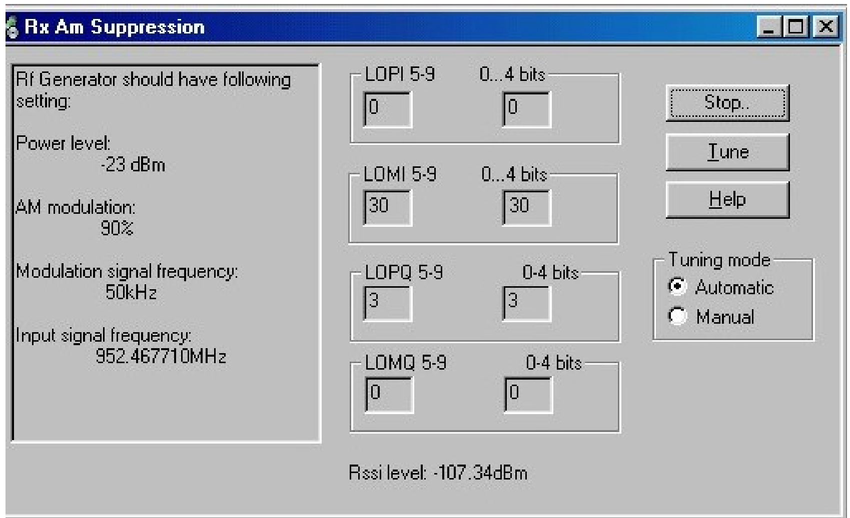




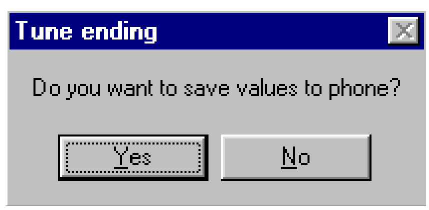

- Set RF generator to state described in left-side window.
- Set the Tuning mode to “Automatic”
- Press the “Tune” button to perform actual tuning.
- The new tuning values and Rssi dBm value are updated.



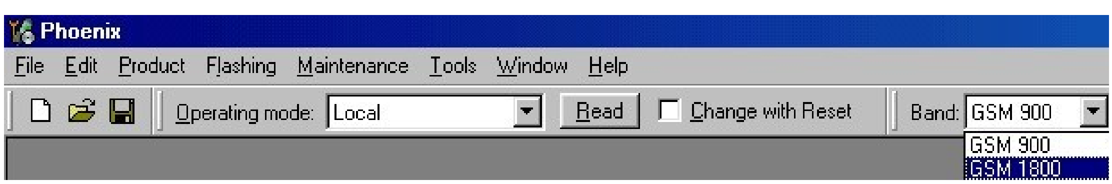

- One "I" and "Q" line values sold be 0, other values 0..31
- RSSI level should be around -107 dBm




- If values shown are within limits, Select “Stop”
- Choose “Yes” to save values to the phone




- **Continue tuning from GSM1800.** Choose the correct band from the dropdown menu.

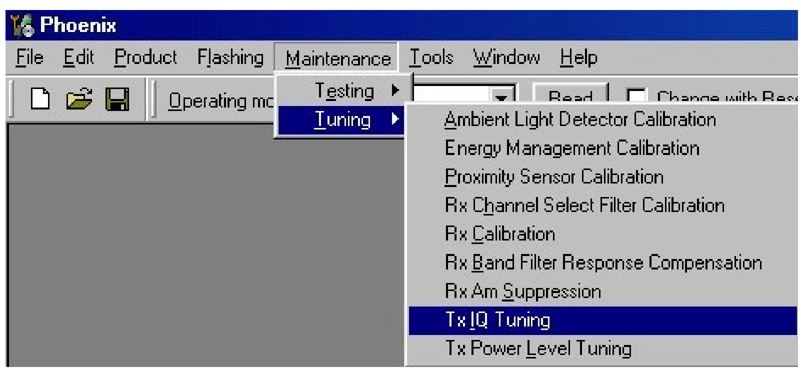



- Repeat the same steps as for the EGSM900 band
- If values shown are within limits, choose “Yes” to save values to the phone
- Close the “RX AM Suppression” – dialog to end tuning

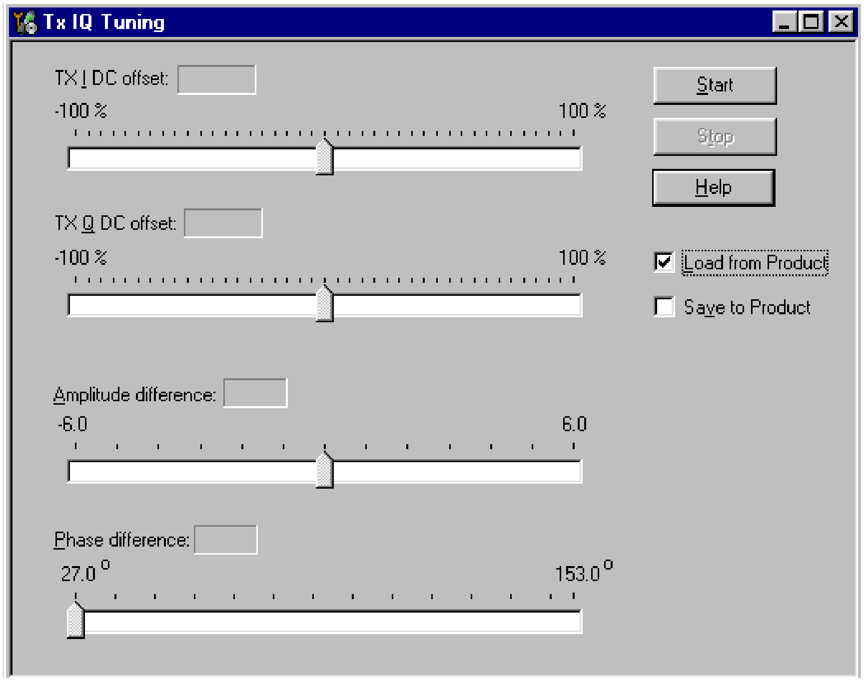
## Transmitter Tunings

### TX I/Q Tuning

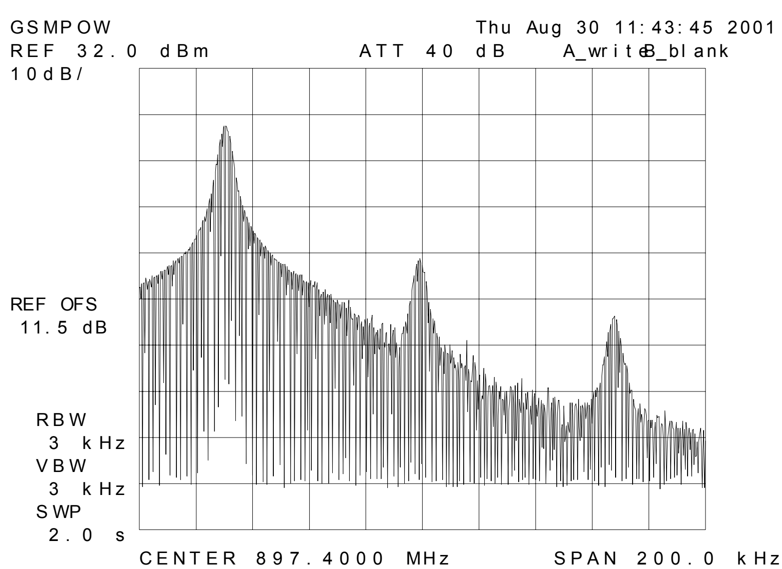
- Spectrum analyzer needed
- Tx IQ Tuning allows changing the Tx I DC Offset, Tx Q DC Offset, Amplitude difference and Phase difference
- Must be done separately on both bands!
- Start TX I/Q Tuning at EGSM (GSM900), then continue at GSM1800 band.
- Remember to take jig and cable attenuations into account!
- Select Maintenance => Tuning => Tx_IQTuning




- Select "Load from product" => Start
- The tuning is done by setting each of the sliders to desired value. The sliders can be changed only when the tuning is ongoing.
- The order of tuning should be same as the order of the sliders e.g. the Tx I DC Offset is tuned first and Phase difference is tuned last.
- Use <=, =>, PgUp or PgDn keys



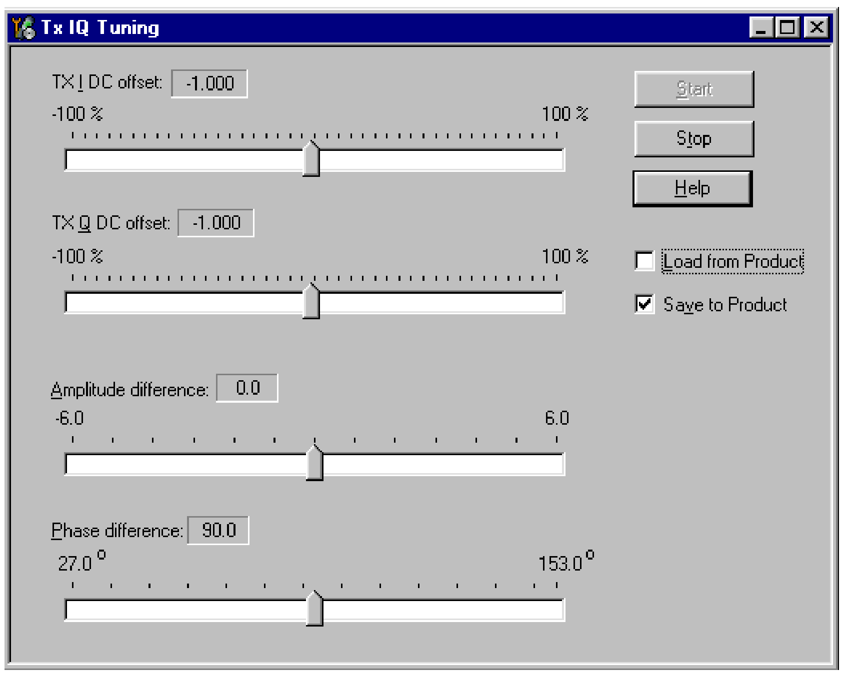

- Set spectrum analyzer center frequency to 897.4 MHz, span 200kHZ, RBW and VWB 3kHz and sweeptime to 2 seconds
- Tune LO leak to minimum with TXI/TXQ DC offset control (**f0 on spectrum analyzer screen**)
- Tune wrong sideband to minimum using Amplitude/Phase difference controls (**f0+68kHz on spectrum analyzer screen**)



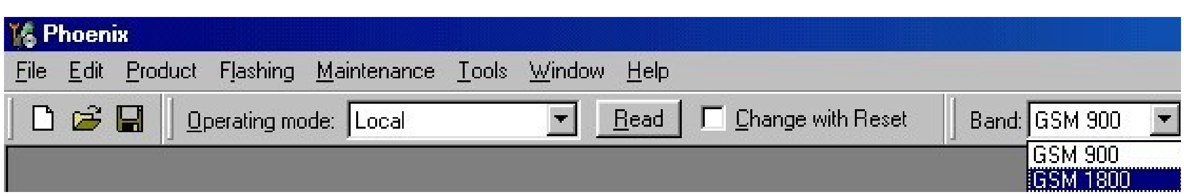
**Typical TX Iq Tuning Values and tuning limits GSM 900:**

| | | |
|---|---|---|
| I DC Offset | -2.5...+0.5 | -6...+6 |
| Q DC Offset | -2.5...+0.5 | -6...+6 |
| Amplitude difference | -0.2...+0.2 | -1...+1 |
| Phase difference | 88.0°....92.0° | 80°...100° |

- If values shown are within limits, check the "Save to product" tick box and choose “Stop” save the new values to the product




- **Continue tuning from GSM1800.** Choose the correct band from the dropdown menu.




- Repeat the same steps as for the EGSM900 band
- Set spectrum analyzer center frequency to 1747.8 MHz, span 200kHZ, RBW and VWB 3kHz and sweeptime to 2 seconds

**Typical TX IQ Tuning Values and tuning limits GSM1800:**

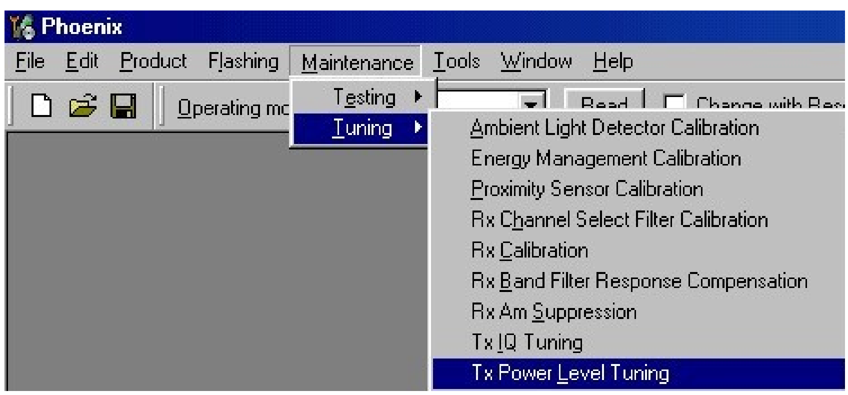
| | | |
|---|---|---|
| I DC Offset | -3.0...0.0 | -6...+6 |
| Q DC Offset | -1.5...+1.0 | -6...+6 |
| Amplitude difference | -0.5...+0.0 | -1...+1 |
| Phase difference | 90.0°...97.0° | 80°...100° |

- If values shown are within limits, check the "Save to product" tick box and choose  “Stop” save the new values to the product

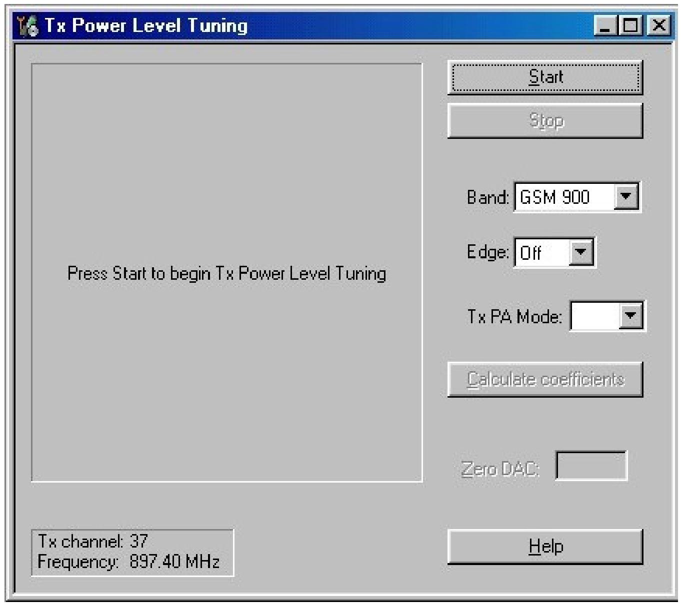
- Close the “TX I/Q Tuning” – dialog to end tuning

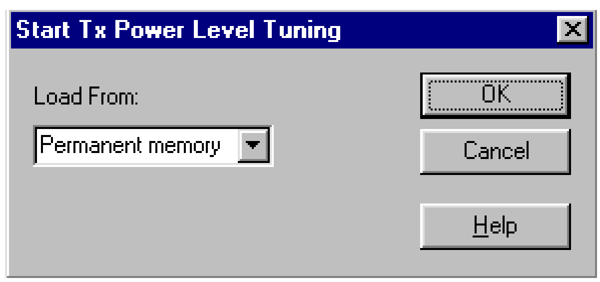
**TX Power Level Tuning**

- Power Meter with peak power sensor (or Spectrum analyzer) needed
- With Tx Power Level Tuning, the coefficients are adjusted for each power level
- Must be done separately on both bands!
- Start Power Level tuning at EGSM (GSM900), then continue at GSM1800 band.
- In EGSM900 band The power level tuning is made for both high and low PA Modes
- In GSM1800 band only for high PA mode.
- Maintenance => Tuning => Tx power level tuning
- Remember to take jig and cable attenuations into account!

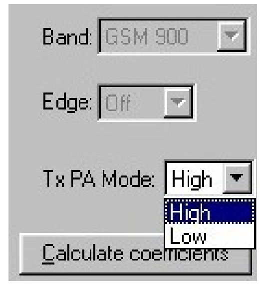



- Select "Start" => "Load from: Permanent memory" => "OK "
- *Note that TX PA mode is "High" at this point.*




- The coefficient table lists the power level, coefficient, target dBm and DAC value for each power level.
- The tuned power level can be chosen by using up and down arrows or mouse.
- The current power level is shown with inverse colors.
- The tuning value can be adjusted with “-“ and “+” keys
- **Tune base level and power levels 19,15 and 5** to target level
- Press "Calculate coefficients"
- **Change TxPA Mode to “Low**” from the drop down menu. When the PA Mode is changed, the previous values are saved in memory and the ones for new mode are shown

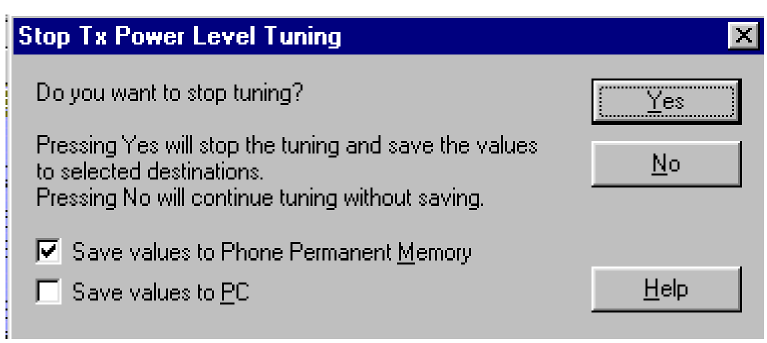



- **Tune power levels 19, 15 and 7** (Levels 5 & 6 are not used, base level tuning not needed)
- Press "Calculate coefficients"

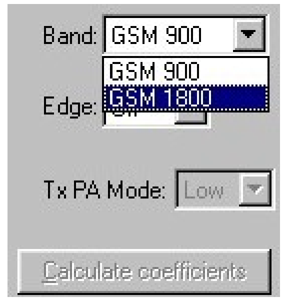
Typical values: EGSM900

| Power level | PA high mode | PA low mode |
|---|---|---|
| 5 | 0.700...0.750 | - |
| 7 | - | 0.530...0.570 |
| 15 | 0.190...0.210 | 0.190...0.210 |
| 19 | 0.170...0.180 | 0.170...0.180 |
| Base | 0.140...0.150 | 0.140...0.150 |

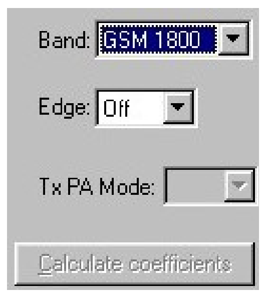
- If values shown are within limits select “Stop” and check “Save values to phone permanent memory”
- Select “Yes” to save values to phone




- **Continue tuning from GSM1800.** Choose the correct band from the dropdown menu.




- Repeat the same steps as for the EGSM900 band above
- Note that In GSM1800 band PA mode can not be changed because tuning is only made in “High” mode




Typical values: GSM1800

| Power level | PA high mode |
|---|---|
| 0 | 0.620...0.670 |
| 11 | 0.170...0.190 |
| 15 | 0.150...0.170 |
| Base | 0.140...0.150 |

- If values shown are within limits select “Stop” and check “Save values to phone permanent memory”
- Select “Yes” to save values to phone
- Close the “TX Power Level Tuning” – dialog to end tuning

# Service Concepts

## New Service Accessories for NHL-2NA

| PART NO | PG | PART NAME |
|---|---|---|
| 0775285 | 67 | MJF-7 Docking station adapter (Does not include CPL-5 RF coupler) |
| 0770370 | 59 | CPL-5 RF coupler |
| 0770443 | 60 | RA7 RF Adapter for NHL-2NA (Screw connection) |
| 0770436 | 640 EUR | TDS-10 GSM RF probe for RF tuning |
| 0775284 | 620 EUR | MJS-9Q module Jig |
| 0775283 | 60 | FLA-21 POS adapter (Single unit, no cables included) |
| 0770286 | 48 | SRT-4 Opening tool (upper part) |
| 0770444 | 48 | SRT-5 Opening tool (lower part) |
| 0770439 | 60 | MJS-79 Soldering jig. Holds phone PWB in automatic soldering machines |
| 0770440 | 79 | TDS-11, Calibration lamp. Ambient light sensor calibration lamp. |
| N.A | N.A. | Flex soldering head made by Metcal. Order info in Service manual |

## Spare parts for service accessories

| PART NO | PG | PART NAME |
|---|---|---|
| 0770335 | 58 | JBS-28, Uniform light source module (Used in camera tests, one piece included in MJF-7. Spare module can be ordered with this code) |
| 0770437 | 31 | Ground pin, TDS-10 Accessory |
| 0770438 | 52 | Insulated antenna pin, TDS-10 accessory |
| 0770497 | N.A. | SRT-8 pin insertion tool for TDS-10 (Price will be announced later) |

MJS-9Q, MJF-7 and FLA-21 Spare pin codes will be announced later with a technical bulletin.

## Service tools used with other NMP products, but needed also for NHL-2NA

| PART NO | PG | PART NAME |
|---|---|---|
| 0730108 | 49 | MBUS Cable DAU-9S to connect PC to service tools |
| 0730218 | 46 | XCS-1, SERVICE CABLE (POS flash cable) |
| 0730178 | 42 | Service Cable XCS-4 (to interconnect FPS-8 and JBV-1/ FLA-21). Mod 10 to mod 10 shielded cable with one separately shielded conductor (MBUS/SCK). |
| 0730012 | 43 | Power Supply Cable PCS-1 for JBV-1 and MJS-9Q |
| 0730114 | 31 | Service Battery Cable SCB-3. Needed for EM-calibrations |
| 0080321 | 800 EUR | FPS-8, Flash Prommer sales pack, incl. Parallel cable, AXS-4, AXP-8 and ACF-8 power supply |
| 0080396 | 8000 EUR | FPS-8C Parallel Flash Prommer |
| 0080346 | 72 | SF12 SRAM Module (2 pcs needed inside FPS-8, Code includes one piece) |
| 0750018 | 56 | PKD-1 Software protection key |
| 0770431 | 48 | SRT-6 Opening tool |
| 0730085 | 46 | XRF-1, RF antenna cable |
| 0081490 | 64 | JBT-9, Bluetooth test box including SMA stub antenna |
| N.A. | ACP-8, | Power supply for JBT-9 |
| 0730185 | 42 | FLC-2, Power Supply Cable to interconnect FPS-8 and FLA-21 |
| 0770298 | 70 | JBV-1, Docking Station |
| 0080541 | 71 | FLS-4S, POS Flash dongle, for E/A area |
| 0080542 | 71 | FLS-4S, POS Flash dongle, for APAC area |
| 0080465 | 65 | LRK-1, LGA rework kit, sales package incl. 0770349 MJS-54, LGA RE-WORK JIG, 0770348 SES-1, STENCIL LGA RE-WORK JIG and 0770381 SPS-1, |

| | | |
|---|---|---|
| | | SOLDERING PASTE SPREADER |
| 0770380 | 49 | SPI-1, SOLDERING PASTE INJECTOR, NOTE shelf life only 1 month |

Prices and price groups are subject to change without notice.

## Service accessory warranty

Service Accessories have 24 months (JBV-1, MJF-7, CPL-5, FLA-21, SRT-4, SRT-5, TDS-10, TDS-11, RA7 and FPS-8 made by PKC Group or Flextronics) and 30 months (MJS-9Q, MJS-79 and LRK-1 made by Sorv-Elektro Oy) warranty period and the Vendors' duty is to repair Accessories also after the warranty.

It is also agreed that Vendors will deliver needed components to you in case you want to repair ServAccs by yourself after the warranty.)

# Setup Instructions

## NHL-2NA SW Update Using FPS-8 and FLA-21

Figure 1: NHL-2NA SW update using FPS-8. Opening tools SRT-4 and SRT-5 are not in the picture.

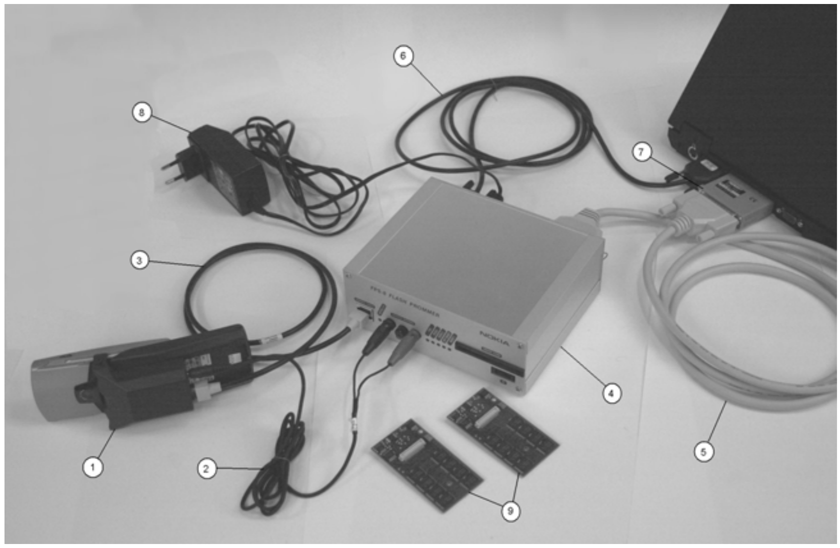



Table 1: Connecting NHL-2NA to PC with FPS-8, list of equipment which is needed

| Item: | Service accessory | | Product code |
|---|---|---|---|
| 1 | Point of Sales flash loading adapter | FLA-21 | 0775283 |
| 2 | Power cable | FLC-2 | 0730185 |
| 3 | Modular cable | XCS-4 | 0730178 |
| 4 | Flash prommer box sales pack | FPS-8 | 0080321 |
| 5 | Printer cable, incl in FPS-8 sales pack | AXP-8 | Not available |
| 6 | D9 – D9 cable, incl in FPS-8 sales pack | AXS-4 | 0730090 |
| 7 | Software protection key | PKD-1 | 0750018 |
| 8 | Power supply, incl in FPS-8 sales pack | ACF-8 | 0680032 |
| 9 | SRAM Module (2 pcs needed inside FPS-8) | SF12 | 0080346 (Code includes one SRAM module) |
| Not in picture | Service SW | | N.A. |
| Not in picture | Opening tool (upper part) | SRT-4 | 0770286 |
| Not in picture | Opening tool (Lower part) | SRT-5 | 0770444 |

## NHL-2NA SW Update in Point of Sales

**Figure 2:** NHL-2NA SW update using FLS-4S. STR-4 and SRT-5 not in picture.

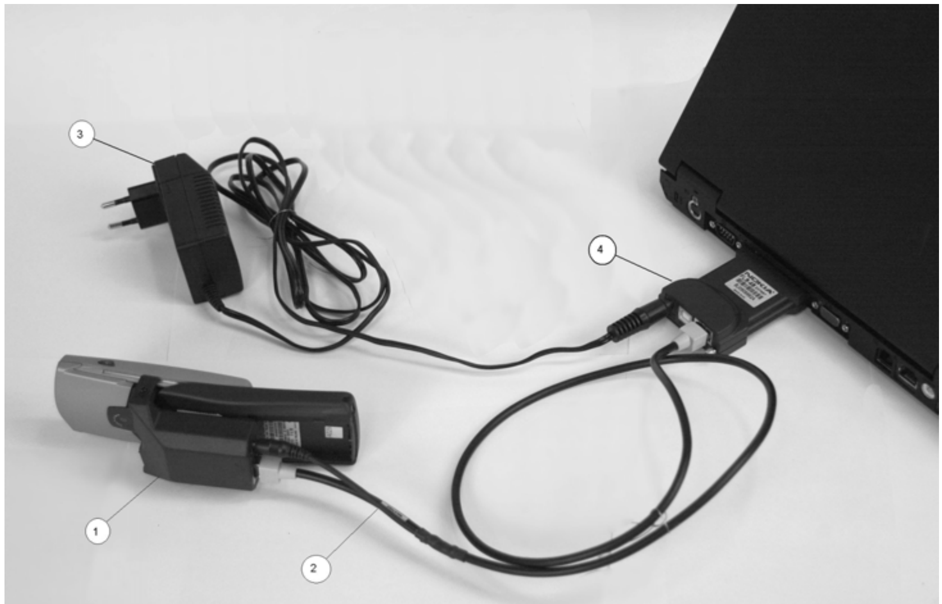
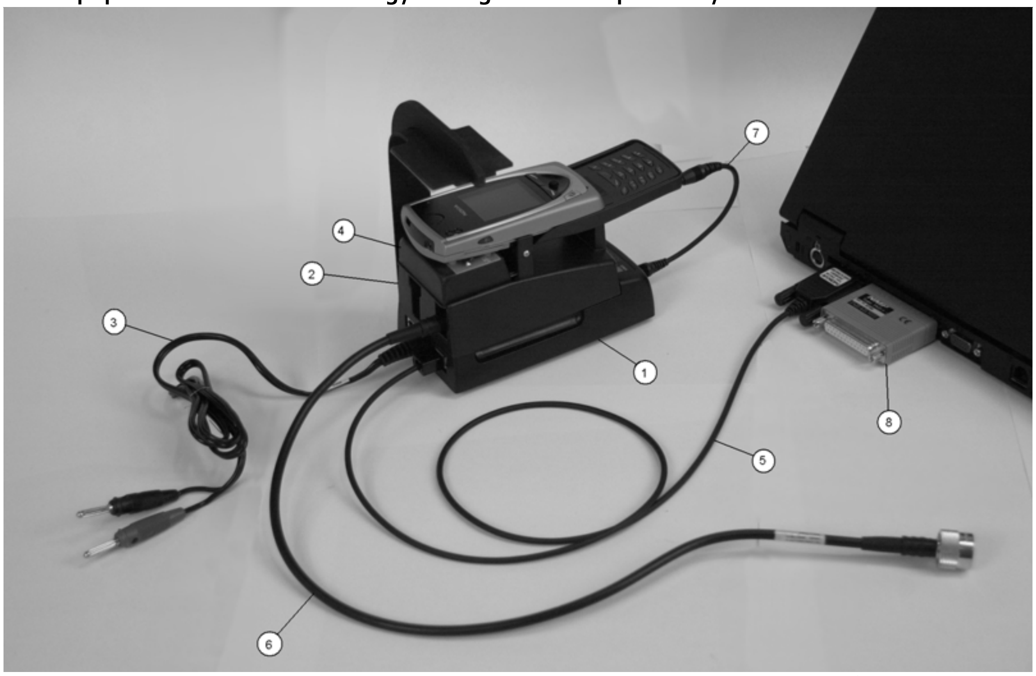



Table 2: NHL-2NA POS flash equipment list:

| **Item:** | **Service accessory** | | **Product code** |
|---|---|---|---|
| 1 | Point of Sales flash loading adapter | FLA-21 | 0775283 |
| 2 | Service cable | XCS-1 | 0730218 |
| 3 | Power supply | ACF-8 | 0680032 |
| 4 | POS flash dongle, for E/A area | FLS-4S | 0080541 |
| | POS flash dongle, for APAC area | FLS-4S | 0080542 |
| Not in picture | Service SW | | N.A. |
| Not in picture | Opening tool (upper part) | SRT-4 | 0770286 |
| Not in picture | Opening tool (Lower part) | SRT-5 | 0770444 |

**Energy Management and Proximity sensor Calibrations and RF Testing (Assembled phone)**

**Figure 3: Equipment for NHL-2NA energy management and proximity sensor calibrations and RF testing.**

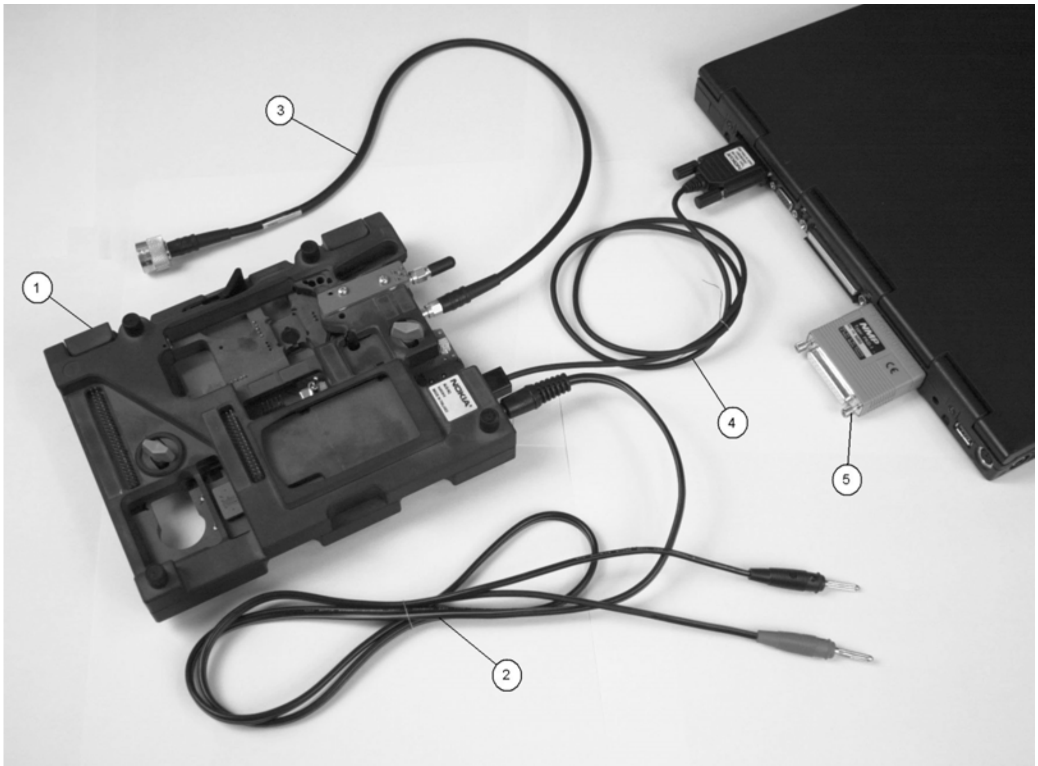



MJF-7 includes also white light source which can be used for Camera image quality checking. Note, RF tuning is not allowed with CPL-5 coupler, it can be used only to test RF.

| **Item:** | **Service accessory** | | **Product code** |
|---|---|---|---|
| 1 | Docking station | JBV-1 | 0770298 |
| 2 | Docking station adapter | MJF-7 | 0775285 |
| 3 | DC power cable | PCS-1 | 0730012 |
| 4 | RF Coupler | CPL-5 | 0770370 |
| 5 | Service Cable | DAU-9S | 0730108 |
| 6 | RF Cable | XRF-1 | 0730085 |
| 7 | DC Cable | SCB-3 | 0730114 |
| 8 | Software protection key | PKD-1 | 0750018 |
| Not in picture | Service SW | | N.A. |
| Not in picture | Opening tool (upper part) | SRT-4 | 0770286 |
| Not in picture | Opening tool (Lower part) | SRT-5 | 0770444 |

**Component level fault finding equipment:**

Figure 4: MJS-9Q module jig is used for component level fault finding. RF tuning and SW update of disassembled phone is also possible.

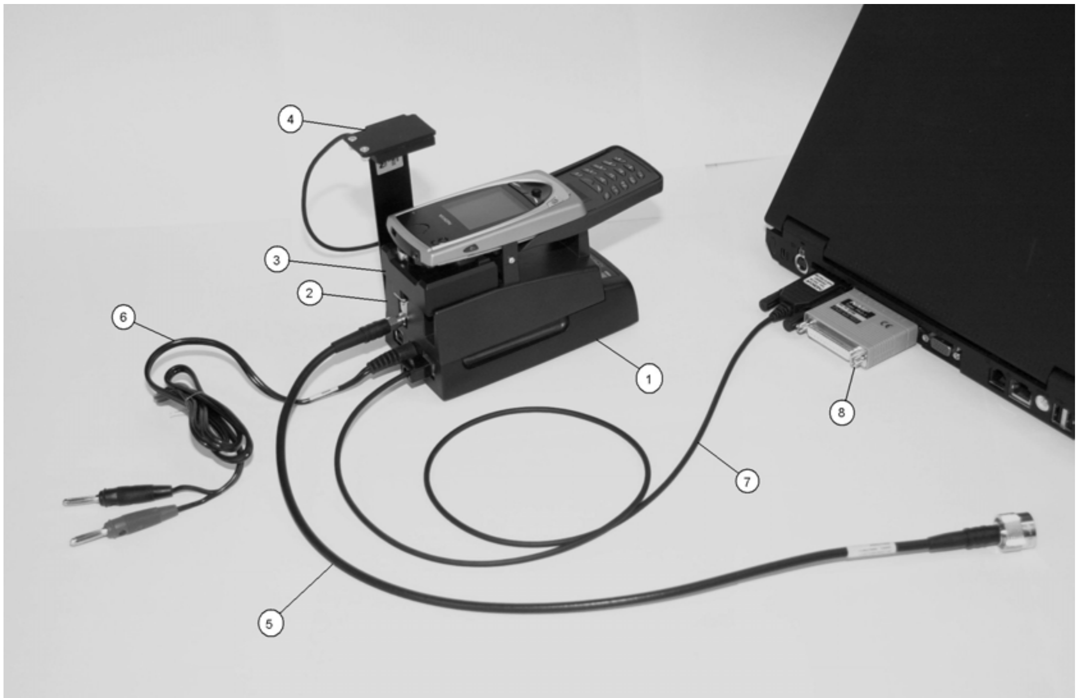



| Item: | Service accessory | | Product code |
|---|---|---|---|
| 1 | Module jig | MJS-9Q | 0775284 |
| 2 | DC power cable | PCS-1 | 0730012 |
| 3 | RF antenna cable | XRF-1 | 0730085 |
| 4 | Service MBUS cable | DAU-9S | 0730108 |
| 5 | Software protection key | PKD-1 | 0750018 |
| Not in picture | Service SW | | N.A. |
| Not in picture | Opening tool (upper part) | SRT-4 | 0770286 |
| Not in picture | Opening tool (Lower part) | SRT-5 | 0770444 |
| Not in picture | Opening tool 'button type' | SRT-6 | 0770431 |

## Assembled Phone RF Tuning and Ambient Light Sensor Calibration Equipment

**Figure 5:** Equipment for NHL-2NA RF tuning and ambient light sensor calibration.

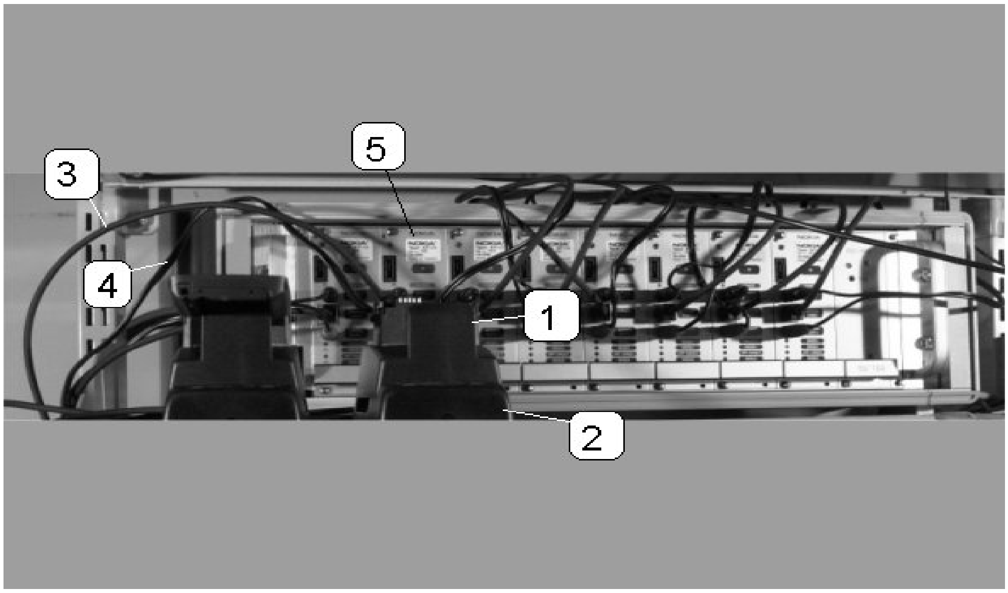



| Item: | Service accessory | | Product code |
|---|---|---|---|
| 1 | JBV-1, Docking station | | 0770298 |
| 2 | MJF-7, Docking station adapter | | 0775285 |
| 3 | TDS-10 GSM RF Probe for RF tuning | | 0770436 |
| 4 | TDS-11 Calibration lamp | | 0770440 |
| 5 | XRF-1, RF antenna cable | | 0730085 |
| 6 | PCS-1, DC power cable | | 0730012 |
| 7 | DAU-9S, Service MBUS cable | | 0730108 |
| 8 | PKD-1, Software protection key | | 0750018 |
| - | RF adapter for NHL-2NA | RA7 | 0770443 |
| Not in picture | Service SW | | N.A. |
| Not in picture | Opening tool (upper part) | SRT-4 | 0770286 |
| Not in picture | Opening tool (Lower part) | SRT-5 | 0770444 |

*Note: RA7 can be used instead of TDS-10. RA7 is less expensive but its use requires opening four transceiver screws every time you use it.*

## SW update using FPS-8C, JBV-1 and MJF-7

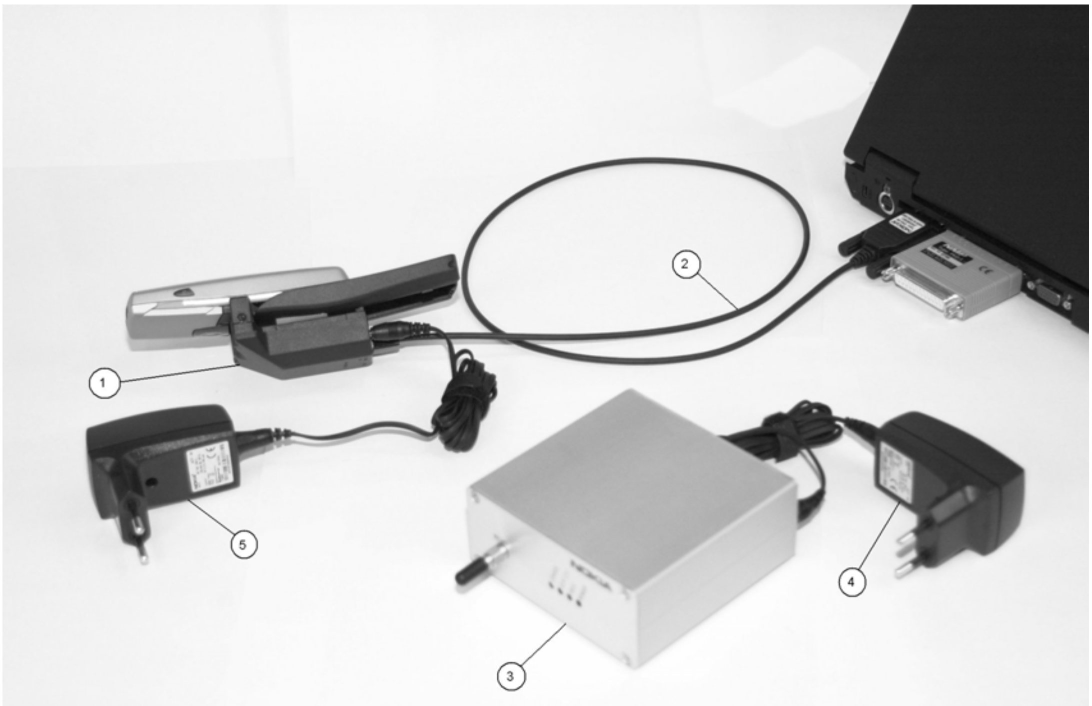
Figure 6: NHL-2NANHL-2NA SW update using FPS-8C, JBV-1 and MJF-7




| Item: | Service accessory | | Product code |
|---|---|---|---|
| 1 | Docking station adapter (8 pcs needed) | MJF-7 | 0775285 (Code includes one piece) |
| 2 | Docking station (8 pcs needed) | JBV-1 | 0770298 (Code includes one piece) |
| 3 | Modular cable (8 pcs needed) | XCS-4 | 0730178 (Code includes one piece) |
| 4 | DC power cable (8 pcs needed) | PCS-1 | 0730012 (Code includes one piece) |
| 5 | FPS-8C (one piece needed) | FPS-8C | 0080396 |
| Not in picture | SRAM Module (16 pcs needed inside FPS-8C) | SF12 | 0080346 (Code includes one SRAM module) |
| Not in picture | D9 – D9 cable, incl in FPS-8C sales pack (1 Pc needed) | AXS-4 | 0730090 |
| Not in picture | Printer cable, incl in FPS-8C sales pack (1 Pc needed) | AXP-8 | N.A. |
| Not in picture | Software protection key | PKD-1 | 0750018 |
| Not in picture | SW, Software (PC SW + SF11C SW) | - | N.A. |

## NHL-2NA Bluetooth Testing

Figure 7: Equipment needed to perform NHL-2NA BT BER test.




| Item: | Service accessory | | Product code |
|---|---|---|---|
| 1 | Point of Sales flash loading adapter | FLA-21 | 0775283 |
| 2 | Service MBUS cable | DAU-9S | 0730108 |
| 3 | Test- & IF-Box Bluetooth | JBT-9 | 0770336 |
| 4,5 | Power supply for JBT-9 and for FLA-21 | ACP-8* | N.A. |

Alternatively, MJF-7 + JBV-1 combination can be used instead of FLA-21.

# Appendix

## Frequency mappings

The following figure shows the RX/TX operating frequency mapping to the frequency synthesizer operating frequency. For a more detailed list of actual channel number mappings see below.

Figure 8: VCO frequency mappings

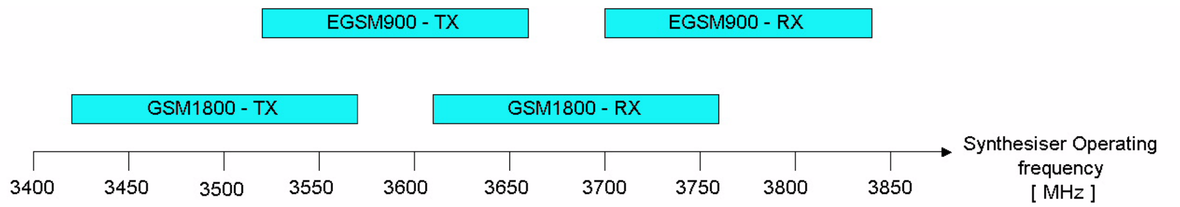



**Table 1 - E-GSM900 Channel to VCO operating frequency mapping**

| 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 | 948 | 3612 | 3792 |
| 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 | 926 | 3524 | 3704 | 5 | 891 | 936 | 3564 | 3744 | 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 | 949 | 3616 | 3796 |
| 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 | 927 | 3528 | 3708 | 10 | 892 | 937 | 3568 | 3748 | 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 | 950 | 3620 | 3800 |
| 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 | 928 | 3532 | 3712 | 15 | 893 | 938 | 3572 | 3752 | 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 | 951 | 3624 | 3804 |
| 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 | 929 | 3536 | 3716 | 20 | 894 | 939 | 3576 | 3756 | 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 | 952 | 3628 | 3808 |
| 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 | 930 | 3540 | 3720 | 25 | 895 | 940 | 3580 | 3760 | 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 | 953 | 3632 | 3812 |
| 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 | 931 | 3544 | 3724 | 30 | 896 | 941 | 3584 | 3764 | 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 | 954 | 3636 | 3816 |
| 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 | 932 | 3548 | 3728 | 35 | 897 | 942 | 3588 | 3768 | 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 | 955 | 3640 | 3820 |
| 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 | 933 | 3552 | 3732 | 40 | 898 | 943 | 3592 | 3772 | 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 | 956 | 3644 | 3824 |
| 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 | 934 | 3556 | 3736 | 45 | 899 | 944 | 3596 | 3776 | 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 | 957 | 3648 | 3828 |
| 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 | 935 | 3560 | 3740 | 50 | 900 | 945 | 3600 | 3780 | 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 | 958 | 3652 | 3832 |
| | | | | | 54 | 900.8 | 945.8 | 3603.2 | 3783.2 | 116 | 913.2 | 958.2 | 3652.8 | 3832.8 |
| | | | | | 55 | 901 | 946 | 3604 | 3784 | 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 | 959 | 3656 | 3836 |
| | | | | | 59 | 901.8 | 946.8 | 3607.2 | 3787.2 | 121 | 914.2 | 959.2 | 3656.8 | 3836.8 |
| | | | | | 60 | 902 | 947 | 3608 | 3788 | 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 |

### Table 2 – GSM1800 Channel to VCO operating frequency mapping

| 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 | 638 | 1735.4 | 1830.4 | 3470.8 | 3660.8 | 764 | 1760.6 | 1855.6 | 3521.2 | 3711.2 |
| 513 | 1710.4 | 1805.4 | 6841.6 | 7221.6 | 639 | 1735.6 | 1830.6 | 3471.2 | 3661.2 | 765 | 1760.8 | 1855.8 | 3521.6 | 3711.6 |
| 514 | 1710.6 | 1805.6 | 6842.4 | 7222.4 | 640 | 1735.8 | 1830.8 | 3471.6 | 3661.6 | 766 | 1761 | 1856 | 3522 | 3712 |
| 515 | 1710.8 | 1805.8 | 6843.2 | 7223.2 | 641 | 1736 | 1831 | 3472 | 3662 | 767 | 1761.2 | 1856.2 | 3522.4 | 3712.4 |
| 516 | 1711 | 1806 | 6844 | 7224 | 642 | 1736.2 | 1831.2 | 3472.4 | 3662.4 | 768 | 1761.4 | 1856.4 | 3522.8 | 3712.8 |
| 517 | 1711.2 | 1806.2 | 6844.8 | 7224.8 | 643 | 1736.4 | 1831.4 | 3472.8 | 3662.8 | 769 | 1761.6 | 1856.6 | 3523.2 | 3713.2 |
| 518 | 1711.4 | 1806.4 | 6845.6 | 7225.6 | 644 | 1736.6 | 1831.6 | 3473.2 | 3663.2 | 770 | 1761.8 | 1856.8 | 3523.6 | 3713.6 |
| 519 | 1711.6 | 1806.6 | 6846.4 | 7226.4 | 645 | 1736.8 | 1831.8 | 3473.6 | 3663.6 | 771 | 1762 | 1857 | 3524 | 3714 |
| 520 | 1711.8 | 1806.8 | 6847.2 | 7227.2 | 646 | 1737 | 1832 | 3474 | 3664 | 772 | 1762.2 | 1857.2 | 3524.4 | 3714.4 |
| 521 | 1712 | 1807 | 6848 | 7228 | 647 | 1737.2 | 1832.2 | 3474.4 | 3664.4 | 773 | 1762.4 | 1857.4 | 3524.8 | 3714.8 |
| 522 | 1712.2 | 1807.2 | 6848.8 | 7228.8 | 648 | 1737.4 | 1832.4 | 3474.8 | 3664.8 | 774 | 1762.6 | 1857.6 | 3525.2 | 3715.2 |
| 523 | 1712.4 | 1807.4 | 6849.6 | 7229.6 | 649 | 1737.6 | 1832.6 | 3475.2 | 3665.2 | 775 | 1762.8 | 1857.8 | 3525.6 | 3715.6 |
| 524 | 1712.6 | 1807.6 | 6850.4 | 7230.4 | 650 | 1737.8 | 1832.8 | 3475.6 | 3665.6 | 776 | 1763 | 1858 | 3526 | 3716 |
| 525 | 1712.8 | 1807.8 | 6851.2 | 7231.2 | 651 | 1738 | 1833 | 3476 | 3666 | 777 | 1763.2 | 1858.2 | 3526.4 | 3716.4 |
| 526 | 1713 | 1808 | 6852 | 7232 | 652 | 1738.2 | 1833.2 | 3476.4 | 3666.4 | 778 | 1763.4 | 1858.4 | 3526.8 | 3716.8 |
| 527 | 1713.2 | 1808.2 | 6852.8 | 7232.8 | 653 | 1738.4 | 1833.4 | 3476.8 | 3666.8 | 779 | 1763.6 | 1858.6 | 3527.2 | 3717.2 |
| 528 | 1713.4 | 1808.4 | 6853.6 | 7233.6 | 654 | 1738.6 | 1833.6 | 3477.2 | 3667.2 | 780 | 1763.8 | 1858.8 | 3527.6 | 3717.6 |
| 529 | 1713.6 | 1808.6 | 6854.4 | 7234.4 | 655 | 1738.8 | 1833.8 | 3477.6 | 3667.6 | 781 | 1764 | 1859 | 3528 | 3718 |
| 530 | 1713.8 | 1808.8 | 6855.2 | 7235.2 | 656 | 1739 | 1834 | 3478 | 3668 | 782 | 1764.2 | 1859.2 | 3528.4 | 3718.4 |
| 531 | 1714 | 1809 | 6856 | 7236 | 657 | 1739.2 | 1834.2 | 3478.4 | 3668.4 | 783 | 1764.4 | 1859.4 | 3528.8 | 3718.8 |
| 532 | 1714.2 | 1809.2 | 6856.8 | 7236.8 | 658 | 1739.4 | 1834.4 | 3478.8 | 3668.8 | 784 | 1764.6 | 1859.6 | 3529.2 | 3719.2 |
| 533 | 1714.4 | 1809.4 | 6857.6 | 7237.6 | 659 | 1739.6 | 1834.6 | 3479.2 | 3669.2 | 785 | 1764.8 | 1859.8 | 3529.6 | 3719.6 |
| 534 | 1714.6 | 1809.6 | 6858.4 | 7238.4 | 660 | 1739.8 | 1834.8 | 3479.6 | 3669.6 | 786 | 1765 | 1860 | 3530 | 3720 |
| 535 | 1714.8 | 1809.8 | 6859.2 | 7239.2 | 661 | 1740 | 1835 | 3480 | 3670 | 787 | 1765.2 | 1860.2 | 3530.4 | 3720.4 |
| 536 | 1715 | 1810 | 6860 | 7240 | 662 | 1740.2 | 1835.2 | 3480.4 | 3670.4 | 788 | 1765.4 | 1860.4 | 3530.8 | 3720.8 |
| 537 | 1715.2 | 1810.2 | 6860.8 | 7240.8 | 663 | 1740.4 | 1835.4 | 3480.8 | 3670.8 | 789 | 1765.6 | 1860.6 | 3531.2 | 3721.2 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 538 | 1715.4 | 1810.4 | 6861.6 | 7241.6 | 664 | 1740.6 | 1835.6 | 3481.2 | 3671.2 | 790 | 1765.8 | 1860.8 | 3531.6 | 3721.6 |
| 539 | 1715.6 | 1810.6 | 6862.4 | 7242.4 | 665 | 1740.8 | 1835.8 | 3481.6 | 3671.6 | 791 | 1766 | 1861 | 3532 | 3722 |
| 540 | 1715.8 | 1810.8 | 6863.2 | 7243.2 | 666 | 1741 | 1836 | 3482 | 3672 | 792 | 1766.2 | 1861.2 | 3532.4 | 3722.4 |
| 541 | 1716 | 1811 | 6864 | 7244 | 667 | 1741.2 | 1836.2 | 3482.4 | 3672.4 | 793 | 1766.4 | 1861.4 | 3532.8 | 3722.8 |
| 542 | 1716.2 | 1811.2 | 6864.8 | 7244.8 | 668 | 1741.4 | 1836.4 | 3482.8 | 3672.8 | 794 | 1766.6 | 1861.6 | 3533.2 | 3723.2 |
| 543 | 1716.4 | 1811.4 | 6865.6 | 7245.6 | 669 | 1741.6 | 1836.6 | 3483.2 | 3673.2 | 795 | 1766.8 | 1861.8 | 3533.6 | 3723.6 |
| 544 | 1716.6 | 1811.6 | 6866.4 | 7246.4 | 670 | 1741.8 | 1836.8 | 3483.6 | 3673.6 | 796 | 1767 | 1862 | 3534 | 3724 |
| 545 | 1716.8 | 1811.8 | 6867.2 | 7247.2 | 671 | 1742 | 1837 | 3484 | 3674 | 797 | 1767.2 | 1862.2 | 3534.4 | 3724.4 |
| 546 | 1717 | 1812 | 6868 | 7248 | 672 | 1742.2 | 1837.2 | 3484.4 | 3674.4 | 798 | 1767.4 | 1862.4 | 3534.8 | 3724.8 |
| 547 | 1717.2 | 1812.2 | 6868.8 | 7248.8 | 673 | 1742.4 | 1837.4 | 3484.8 | 3674.8 | 799 | 1767.6 | 1862.6 | 3535.2 | 3725.2 |
| 548 | 1717.4 | 1812.4 | 6869.6 | 7249.6 | 674 | 1742.6 | 1837.6 | 3485.2 | 3675.2 | 800 | 1767.8 | 1862.8 | 3535.6 | 3725.6 |
| 549 | 1717.6 | 1812.6 | 6870.4 | 7250.4 | 675 | 1742.8 | 1837.8 | 3485.6 | 3675.6 | 801 | 1768 | 1863 | 3536 | 3726 |
| 550 | 1717.8 | 1812.8 | 6871.2 | 7251.2 | 676 | 1743 | 1838 | 3486 | 3676 | 802 | 1768.2 | 1863.2 | 3536.4 | 3726.4 |
| 551 | 1718 | 1813 | 6872 | 7252 | 677 | 1743.2 | 1838.2 | 3486.4 | 3676.4 | 803 | 1768.4 | 1863.4 | 3536.8 | 3726.8 |
| 552 | 1718.2 | 1813.2 | 6872.8 | 7252.8 | 678 | 1743.4 | 1838.4 | 3486.8 | 3676.8 | 804 | 1768.6 | 1863.6 | 3537.2 | 3727.2 |
| 553 | 1718.4 | 1813.4 | 6873.6 | 7253.6 | 679 | 1743.6 | 1838.6 | 3487.2 | 3677.2 | 805 | 1768.8 | 1863.8 | 3537.6 | 3727.6 |
| 554 | 1718.6 | 1813.6 | 6874.4 | 7254.4 | 680 | 1743.8 | 1838.8 | 3487.6 | 3677.6 | 806 | 1769 | 1864 | 3538 | 3728 |
| 555 | 1718.8 | 1813.8 | 6875.2 | 7255.2 | 681 | 1744 | 1839 | 3488 | 3678 | 807 | 1769.2 | 1864.2 | 3538.4 | 3728.4 |
| 556 | 1719 | 1814 | 6876 | 7256 | 682 | 1744.2 | 1839.2 | 3488.4 | 3678.4 | 808 | 1769.4 | 1864.4 | 3538.8 | 3728.8 |
| 557 | 1719.2 | 1814.2 | 6876.8 | 7256.8 | 683 | 1744.4 | 1839.4 | 3488.8 | 3678.8 | 809 | 1769.6 | 1864.6 | 3539.2 | 3729.2 |
| 558 | 1719.4 | 1814.4 | 6877.6 | 7257.6 | 684 | 1744.6 | 1839.6 | 3489.2 | 3679.2 | 810 | 1769.8 | 1864.8 | 3539.6 | 3729.6 |
| 559 | 1719.6 | 1814.6 | 6878.4 | 7258.4 | 685 | 1744.8 | 1839.8 | 3489.6 | 3679.6 | 811 | 1770 | 1865 | 3540 | 3730 |
| 560 | 1719.8 | 1814.8 | 6879.2 | 7259.2 | 686 | 1745 | 1840 | 3490 | 3680 | 812 | 1770.2 | 1865.2 | 3540.4 | 3730.4 |
| 561 | 1720 | 1815 | 6880 | 7260 | 687 | 1745.2 | 1840.2 | 3490.4 | 3680.4 | 813 | 1770.4 | 1865.4 | 3540.8 | 3730.8 |
| 562 | 1720.2 | 1815.2 | 6880.8 | 7260.8 | 688 | 1745.4 | 1840.4 | 3490.8 | 3680.8 | 814 | 1770.6 | 1865.6 | 3541.2 | 3731.2 |
| 563 | 1720.4 | 1815.4 | 6881.6 | 7261.6 | 689 | 1745.6 | 1840.6 | 3491.2 | 3681.2 | 815 | 1770.8 | 1865.8 | 3541.6 | 3731.6 |
| 564 | 1720.6 | 1815.6 | 6882.4 | 7262.4 | 690 | 1745.8 | 1840.8 | 3491.6 | 3681.6 | 816 | 1771 | 1866 | 3542 | 3732 |
| 565 | 1720.8 | 1815.8 | 6883.2 | 7263.2 | 691 | 1746 | 1841 | 3492 | 3682 | 817 | 1771.2 | 1866.2 | 3542.4 | 3732.4 |
| 566 | 1721 | 1816 | 6884 | 7264 | 692 | 1746.2 | 1841.2 | 3492.4 | 3682.4 | 818 | 1771.4 | 1866.4 | 3542.8 | 3732.8 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 567 | 1721.2 | 1816.2 | 6884.8 | 7264.8 | 693 | 1746.4 | 1841.4 | 3492.8 | 3682.8 | 819 | 1771.6 | 1866.6 | 3543.2 | 3733.2 |
| 568 | 1721.4 | 1816.4 | 6885.6 | 7265.6 | 694 | 1746.6 | 1841.6 | 3493.2 | 3683.2 | 820 | 1771.8 | 1866.8 | 3543.6 | 3733.6 |
| 569 | 1721.6 | 1816.6 | 6886.4 | 7266.4 | 695 | 1746.8 | 1841.8 | 3493.6 | 3683.6 | 821 | 1772 | 1867 | 3544 | 3734 |
| 570 | 1721.8 | 1816.8 | 6887.2 | 7267.2 | 696 | 1747 | 1842 | 3494 | 3684 | 822 | 1772.2 | 1867.2 | 3544.4 | 3734.4 |
| 571 | 1722 | 1817 | 6888 | 7268 | 697 | 1747.2 | 1842.2 | 3494.4 | 3684.4 | 823 | 1772.4 | 1867.4 | 3544.8 | 3734.8 |
| 572 | 1722.2 | 1817.2 | 6888.8 | 7268.8 | 698 | 1747.4 | 1842.4 | 3494.8 | 3684.8 | 824 | 1772.6 | 1867.6 | 3545.2 | 3735.2 |
| 573 | 1722.4 | 1817.4 | 6889.6 | 7269.6 | 699 | 1747.6 | 1842.6 | 3495.2 | 3685.2 | 825 | 1772.8 | 1867.8 | 3545.6 | 3735.6 |
| 574 | 1722.6 | 1817.6 | 6890.4 | 7270.4 | 700 | 1747.8 | 1842.8 | 3495.6 | 3685.6 | 826 | 1773 | 1868 | 3546 | 3736 |
| 575 | 1722.8 | 1817.8 | 3445.6 | 3635.6 | 701 | 1748 | 1843 | 3496 | 3686 | 827 | 1773.2 | 1868.2 | 3546.4 | 3736.4 |
| 576 | 1723 | 1818 | 3446 | 3636 | 702 | 1748.2 | 1843.2 | 3496.4 | 3686.4 | 828 | 1773.4 | 1868.4 | 3546.8 | 3736.8 |
| 577 | 1723.2 | 1818.2 | 3446.4 | 3636.4 | 703 | 1748.4 | 1843.4 | 3496.8 | 3686.8 | 829 | 1773.6 | 1868.6 | 3547.2 | 3737.2 |
| 578 | 1723.4 | 1818.4 | 3446.8 | 3636.8 | 704 | 1748.6 | 1843.6 | 3497.2 | 3687.2 | 830 | 1773.8 | 1868.8 | 3547.6 | 3737.6 |
| 579 | 1723.6 | 1818.6 | 3447.2 | 3637.2 | 705 | 1748.8 | 1843.8 | 3497.6 | 3687.6 | 831 | 1774 | 1869 | 3548 | 3738 |
| 580 | 1723.8 | 1818.8 | 3447.6 | 3637.6 | 706 | 1749 | 1844 | 3498 | 3688 | 832 | 1774.2 | 1869.2 | 3548.4 | 3738.4 |
| 581 | 1724 | 1819 | 3448 | 3638 | 707 | 1749.2 | 1844.2 | 3498.4 | 3688.4 | 833 | 1774.4 | 1869.4 | 3548.8 | 3738.8 |
| 582 | 1724.2 | 1819.2 | 3448.4 | 3638.4 | 708 | 1749.4 | 1844.4 | 3498.8 | 3688.8 | 834 | 1774.6 | 1869.6 | 3549.2 | 3739.2 |
| 583 | 1724.4 | 1819.4 | 3448.8 | 3638.8 | 709 | 1749.6 | 1844.6 | 3499.2 | 3689.2 | 835 | 1774.8 | 1869.8 | 3549.6 | 3739.6 |
| 584 | 1724.6 | 1819.6 | 3449.2 | 3639.2 | 710 | 1749.8 | 1844.8 | 3499.6 | 3689.6 | 836 | 1775 | 1870 | 3550 | 3740 |
| 585 | 1724.8 | 1819.8 | 3449.6 | 3639.6 | 711 | 1750 | 1845 | 3500 | 3690 | 837 | 1775.2 | 1870.2 | 3550.4 | 3740.4 |
| 586 | 1725 | 1820 | 3450 | 3640 | 712 | 1750.2 | 1845.2 | 3500.4 | 3690.4 | 838 | 1775.4 | 1870.4 | 3550.8 | 3740.8 |
| 587 | 1725.2 | 1820.2 | 3450.4 | 3640.4 | 713 | 1750.4 | 1845.4 | 3500.8 | 3690.8 | 839 | 1775.6 | 1870.6 | 3551.2 | 3741.2 |
| 588 | 1725.4 | 1820.4 | 3450.8 | 3640.8 | 714 | 1750.6 | 1845.6 | 3501.2 | 3691.2 | 840 | 1775.8 | 1870.8 | 3551.6 | 3741.6 |
| 589 | 1725.6 | 1820.6 | 3451.2 | 3641.2 | 715 | 1750.8 | 1845.8 | 3501.6 | 3691.6 | 841 | 1776 | 1871 | 3552 | 3742 |
| 590 | 1725.8 | 1820.8 | 3451.6 | 3641.6 | 716 | 1751 | 1846 | 3502 | 3692 | 842 | 1776.2 | 1871.2 | 3552.4 | 3742.4 |
| 591 | 1726 | 1821 | 3452 | 3642 | 717 | 1751.2 | 1846.2 | 3502.4 | 3692.4 | 843 | 1776.4 | 1871.4 | 3552.8 | 3742.8 |
| 592 | 1726.2 | 1821.2 | 3452.4 | 3642.4 | 718 | 1751.4 | 1846.4 | 3502.8 | 3692.8 | 844 | 1776.6 | 1871.6 | 3553.2 | 3743.2 |
| 593 | 1726.4 | 1821.4 | 3452.8 | 3642.8 | 719 | 1751.6 | 1846.6 | 3503.2 | 3693.2 | 845 | 1776.8 | 1871.8 | 3553.6 | 3743.6 |
| 594 | 1726.6 | 1821.6 | 3453.2 | 3643.2 | 720 | 1751.8 | 1846.8 | 3503.6 | 3693.6 | 846 | 1777 | 1872 | 3554 | 3744 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 595 | 1726.8 | 1821.8 | 3453.6 | 3643.6 | 721 | 1752 | 1847 | 3504 | 3694 | 847 | 1777.2 | 1872.2 | 3554.4 | 3744.4 |
| 596 | 1727 | 1822 | 3454 | 3644 | 722 | 1752.2 | 1847.2 | 3504.4 | 3694.4 | 848 | 1777.4 | 1872.4 | 3554.8 | 3744.8 |
| 597 | 1727.2 | 1822.2 | 3454.4 | 3644.4 | 723 | 1752.4 | 1847.4 | 3504.8 | 3694.8 | 849 | 1777.6 | 1872.6 | 3555.2 | 3745.2 |
| 598 | 1727.4 | 1822.4 | 3454.8 | 3644.8 | 724 | 1752.6 | 1847.6 | 3505.2 | 3695.2 | 850 | 1777.8 | 1872.8 | 3555.6 | 3745.6 |
| 599 | 1727.6 | 1822.6 | 3455.2 | 3645.2 | 725 | 1752.8 | 1847.8 | 3505.6 | 3695.6 | 851 | 1778 | 1873 | 3556 | 3746 |
| 600 | 1727.8 | 1822.8 | 3455.6 | 3645.6 | 726 | 1753 | 1848 | 3506 | 3696 | 852 | 1778.2 | 1873.2 | 3556.4 | 3746.4 |
| 601 | 1728 | 1823 | 3456 | 3646 | 727 | 1753.2 | 1848.2 | 3506.4 | 3696.4 | 853 | 1778.4 | 1873.4 | 3556.8 | 3746.8 |
| 602 | 1728.2 | 1823.2 | 3456.4 | 3646.4 | 728 | 1753.4 | 1848.4 | 3506.8 | 3696.8 | 854 | 1778.6 | 1873.6 | 3557.2 | 3747.2 |
| 603 | 1728.4 | 1823.4 | 3456.8 | 3646.8 | 729 | 1753.6 | 1848.6 | 3507.2 | 3697.2 | 855 | 1778.8 | 1873.8 | 3557.6 | 3747.6 |
| 604 | 1728.6 | 1823.6 | 3457.2 | 3647.2 | 730 | 1753.8 | 1848.8 | 3507.6 | 3697.6 | 856 | 1779 | 1874 | 3558 | 3748 |
| 605 | 1728.8 | 1823.8 | 3457.6 | 3647.6 | 731 | 1754 | 1849 | 3508 | 3698 | 857 | 1779.2 | 1874.2 | 3558.4 | 3748.4 |
| 606 | 1729 | 1824 | 3458 | 3648 | 732 | 1754.2 | 1849.2 | 3508.4 | 3698.4 | 858 | 1779.4 | 1874.4 | 3558.8 | 3748.8 |
| 607 | 1729.2 | 1824.2 | 3458.4 | 3648.4 | 733 | 1754.4 | 1849.4 | 3508.8 | 3698.8 | 859 | 1779.6 | 1874.6 | 3559.2 | 3749.2 |
| 608 | 1729.4 | 1824.4 | 3458.8 | 3648.8 | 734 | 1754.6 | 1849.6 | 3509.2 | 3699.2 | 860 | 1779.8 | 1874.8 | 3559.6 | 3749.6 |
| 609 | 1729.6 | 1824.6 | 3459.2 | 3649.2 | 735 | 1754.8 | 1849.8 | 3509.6 | 3699.6 | 861 | 1780 | 1875 | 3560 | 3750 |
| 610 | 1729.8 | 1824.8 | 3459.6 | 3649.6 | 736 | 1755 | 1850 | 3510 | 3700 | 862 | 1780.2 | 1875.2 | 3560.4 | 3750.4 |
| 611 | 1730 | 1825 | 3460 | 3650 | 737 | 1755.2 | 1850.2 | 3510.4 | 3700.4 | 863 | 1780.4 | 1875.4 | 3560.8 | 3750.8 |
| 612 | 1730.2 | 1825.2 | 3460.4 | 3650.4 | 738 | 1755.4 | 1850.4 | 3510.8 | 3700.8 | 864 | 1780.6 | 1875.6 | 3561.2 | 3751.2 |
| 613 | 1730.4 | 1825.4 | 3460.8 | 3650.8 | 739 | 1755.6 | 1850.6 | 3511.2 | 3701.2 | 865 | 1780.8 | 1875.8 | 3561.6 | 3751.6 |
| 614 | 1730.6 | 1825.6 | 3461.2 | 3651.2 | 740 | 1755.8 | 1850.8 | 3511.6 | 3701.6 | 866 | 1781 | 1876 | 3562 | 3752 |
| 615 | 1730.8 | 1825.8 | 3461.6 | 3651.6 | 741 | 1756 | 1851 | 3512 | 3702 | 867 | 1781.2 | 1876.2 | 3562.4 | 3752.4 |
| 616 | 1731 | 1826 | 3462 | 3652 | 742 | 1756.2 | 1851.2 | 3512.4 | 3702.4 | 868 | 1781.4 | 1876.4 | 3562.8 | 3752.8 |
| 617 | 1731.2 | 1826.2 | 3462.4 | 3652.4 | 743 | 1756.4 | 1851.4 | 3512.8 | 3702.8 | 869 | 1781.6 | 1876.6 | 3563.2 | 3753.2 |
| 618 | 1731.4 | 1826.4 | 3462.8 | 3652.8 | 744 | 1756.6 | 1851.6 | 3513.2 | 3703.2 | 870 | 1781.8 | 1876.8 | 3563.6 | 3753.6 |
| 619 | 1731.6 | 1826.6 | 3463.2 | 3653.2 | 745 | 1756.8 | 1851.8 | 3513.6 | 3703.6 | 871 | 1782 | 1877 | 3564 | 3754 |
| 620 | 1731.8 | 1826.8 | 3463.6 | 3653.6 | 746 | 1757 | 1852 | 3514 | 3704 | 872 | 1782.2 | 1877.2 | 3564.4 | 3754.4 |
| 621 | 1732 | 1827 | 3464 | 3654 | 747 | 1757.2 | 1852.2 | 3514.4 | 3704.4 | 873 | 1782.4 | 1877.4 | 3564.8 | 3754.8 |
| 622 | 1732.2 | 1827.2 | 3464.4 | 3654.4 | 748 | 1757.4 | 1852.4 | 3514.8 | 3704.8 | 874 | 1782.6 | 1877.6 | 3565.2 | 3755.2 |
| 623 | 1732.4 | 1827.4 | 3464.8 | 3654.8 | 749 | 1757.6 | 1852.6 | 3515.2 | 3705.2 | 875 | 1782.8 | 1877.8 | 3565.6 | 3755.6 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 624 | 1732.6 | 1827.6 | 3465.2 | 3655.2 | 750 | 1757.8 | 1852.8 | 3515.6 | 3705.6 | 876 | 1783 | 1878 | 3566 | 3756 |
| 625 | 1732.8 | 1827.8 | 3465.6 | 3655.6 | 751 | 1758 | 1853 | 3516 | 3706 | 877 | 1783.2 | 1878.2 | 3566.4 | 3756.4 |
| 626 | 1733 | 1828 | 3466 | 3656 | 752 | 1758.2 | 1853.2 | 3516.4 | 3706.4 | 878 | 1783.4 | 1878.4 | 3566.8 | 3756.8 |
| 627 | 1733.2 | 1828.2 | 3466.4 | 3656.4 | 753 | 1758.4 | 1853.4 | 3516.8 | 3706.8 | 879 | 1783.6 | 1878.6 | 3567.2 | 3757.2 |
| 628 | 1733.4 | 1828.4 | 3466.8 | 3656.8 | 754 | 1758.6 | 1853.6 | 3517.2 | 3707.2 | 880 | 1783.8 | 1878.8 | 3567.6 | 3757.6 |
| 629 | 1733.6 | 1828.6 | 3467.2 | 3657.2 | 755 | 1758.8 | 1853.8 | 3517.6 | 3707.6 | 881 | 1784 | 1879 | 3568 | 3758 |
| 630 | 1733.8 | 1828.8 | 3467.6 | 3657.6 | 756 | 1759 | 1854 | 3518 | 3708 | 882 | 1784.2 | 1879.2 | 3568.4 | 3758.4 |
| 631 | 1734 | 1829 | 3468 | 3658 | 757 | 1759.2 | 1854.2 | 3518.4 | 3708.4 | 883 | 1784.4 | 1879.4 | 3568.8 | 3758.8 |
| 632 | 1734.2 | 1829.2 | 3468.4 | 3658.4 | 758 | 1759.4 | 1854.4 | 3518.8 | 3708.8 | 884 | 1784.6 | 1879.6 | 3569.2 | 3759.2 |
| 633 | 1734.4 | 1829.4 | 3468.8 | 3658.8 | 759 | 1759.6 | 1854.6 | 3519.2 | 3709.2 | 885 | 1784.8 | 1879.8 | 3569.6 | 3759.6 |
| 634 | 1734.6 | 1829.6 | 3469.2 | 3659.2 | 760 | 1759.8 | 1854.8 | 3519.6 | 3709.6 | | | | | |
| 635 | 1734.8 | 1829.8 | 3469.6 | 3659.6 | 761 | 1760 | 1855 | 3520 | 3710 | | | | | |
| 636 | 1735 | 1830 | 3470 | 3660 | 762 | 1760.2 | 1855.2 | 3520.4 | 3710.4 | | | | | |
| 637 | 1735.2 | 1830.2 | 3470.4 | 3660.4 | 763 | 1760.4 | 1855.4 | 3520.8 | 3710.8 | | | | | |

  

# Service Tools

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## Table of Contents

# JBV-1 Docking Station and MJF-7 Adapter

The JBV-1 Docking Station has been designed for calibration and software update use. The MJF-7 Docking Station Adapter makes signal connections to the phone. JBV-1 and MJF-7 are used as one unit.

JBV-1 main electric functions are:
- adjustable VBATT calibration voltage, current measurement limit voltage ”VCHAR”, current measurement calibration current ”ICHAR”
- adjustable ADC calibration voltage via BTEMP and BSI signal
- BTEMP and BSI calibration resistor
- signals from FBUS to the phone via parallel jig
- control via FBUS or USB
- Flash OK/FAIL indication

In calibration mode JBV-1 is powered by external power supply 11-16V DC. In flashing power for the phone can be taken from FPS-8 or external power supply 11-16V DC.

MJF-7 main electric functions are:

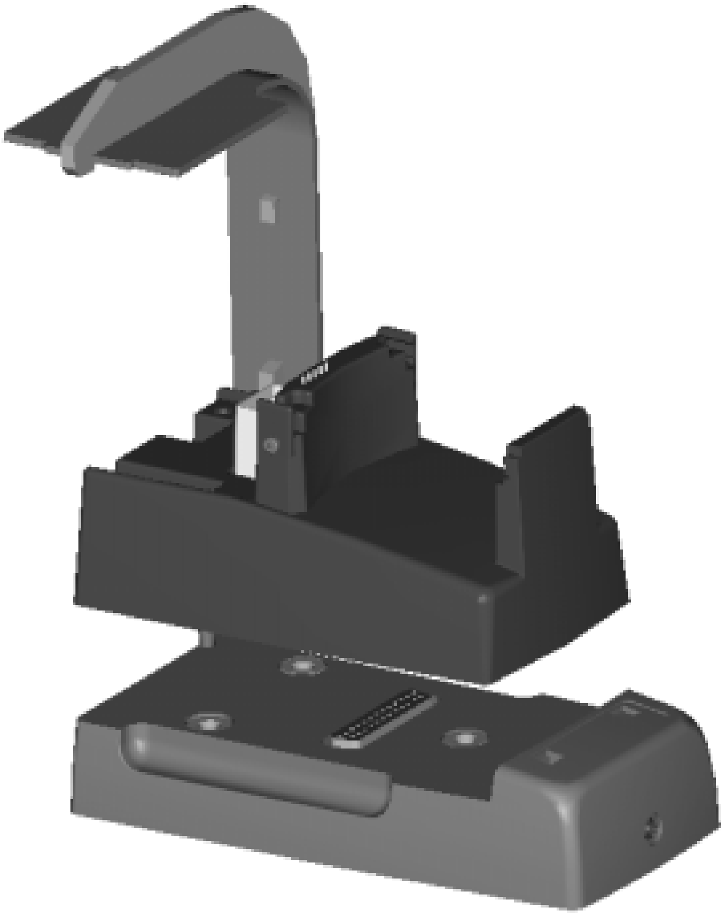
- phone recognizing from BTEMP
- filters of FBUS signals
- Proximity sensor calibration plate
- White light source for camera testing
- Possibility to use TDS-11 ambient light sensor calibration lamp
- Possiblity to use TDS-10 for RF tuning or CPL-5 for RF measurement

## Product Code

| | |
|---|---|
| JBV-1 Docking Station: | 0770298 |
| MJF-7 Docking Station Adapter: | 0775285 |

## View of MJF-7 with JBV-1

**Figure 1: MJF-1 and JBV-1**



## Spare parts for MJF-7

MJF-7 has a white light source integrated to the structure for Camera Testing. Light source has limited lifetime and it starts to lose brightness as it is used. It is recommended that the light source be changed every 1000 hours of use.

Spare part code: JBS-28 Uniform Light source module 0770335

# CPL-5 RF coupler

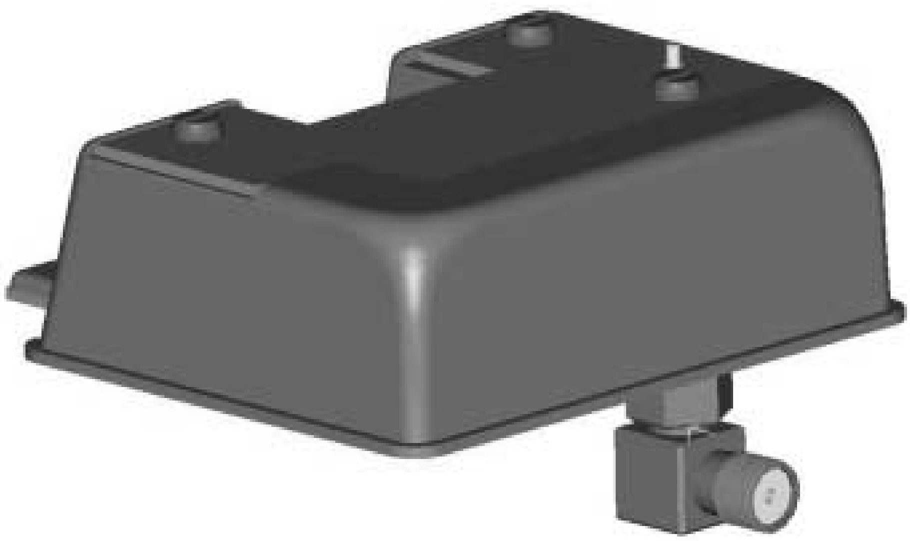
The CPL-5 RF coupler has been designed to be used with MJF-7 and JBV-1. CPL-5 allows service technician to measure performance of NHL-2GSM RF. RF tuning with CPL-5 is not allowed.

## Product Code

CPL-5 RF coupler: 0770370

## View of CPL-5

**Figure 2: CPL-5**



## RF-Coupler CPL-5: measured losses

Attenuation values are printed on the service accessory

# TDS-10 GSM RF probe for RF tuning

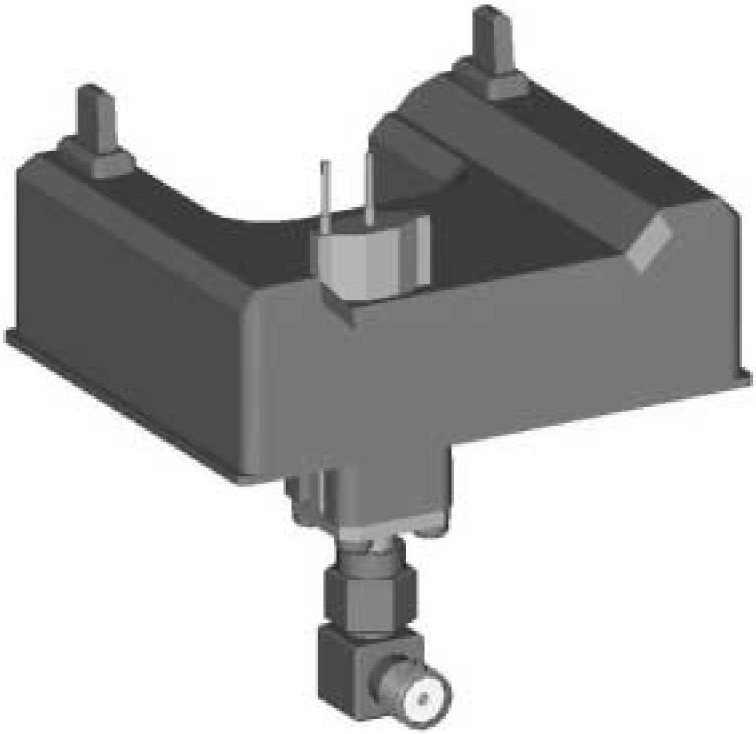
GSM RF probe has been developed for repair places where easy access for RF tuning s is essential. Only Sim cover of the phone has to be removed and then phone is ready for RF tuning. This probe has to be used together with MJF-7 and JBV-1.

## Product Code

TDS-10 GSM RF probe for RF tuning 0770436

## View of TDS-10

**Figure 3: TDS-10**



## Spare pins for TDS-10

The pins which make RF connection to phone are quite sensitive for mechanical stress. Spare pins are available with the following codes.

| | |
|---|---|
| Ground pin, TDS-10 Accessory | 0770437 |
| Insulated antenna pin, TDS-10 Accessory | 0770438 |

Insulated pin can be hard to insert without experience. The following tool is available to help in this operation:

| | |
|---|---|
| SRT-8 Insertion tool | 0770497 |

# TDS-11 Calibration lamp

Ambient light sensor of NHL-2 tranceiver needs to be calibrated after certain service operations. TDS-11 must be used together with JBV-1 and MJF-7.

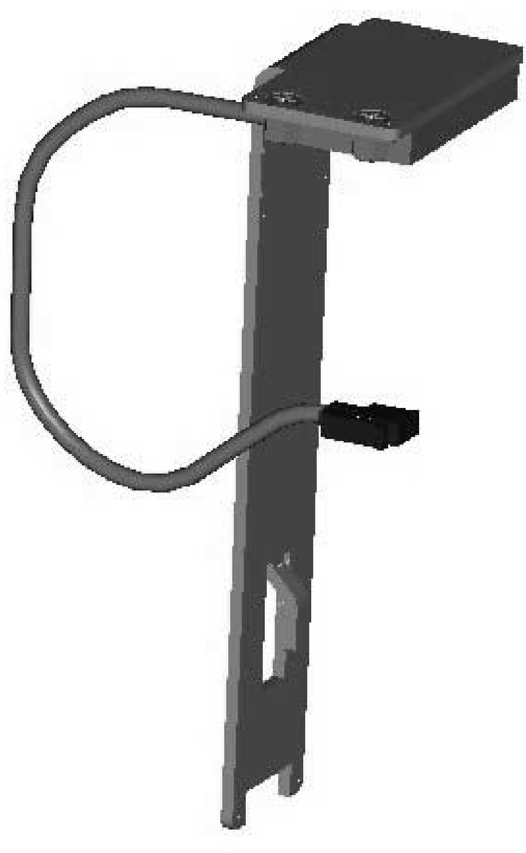
Note! TDS-10 is made out of metal and it is not recommended to keep it installed when making coupler measurement or RF tunings with TDS-11. Remove TDS-10 always from MJF-7 when not using it. TDS-10 brightness also weakens in lond term use. Ambient light sensor calibration system (JBV-1+MJF-7+TDS-11) must be calibrated time to time with golden phones (Selected phones from production line) in regular intervals.

## Product Code

| | |
|---|---|
| TDS-11 Calibration lamp | 0770440 |

## View of TDS-11

**Figure 4: TDS-11**



# RA7 RF adapter

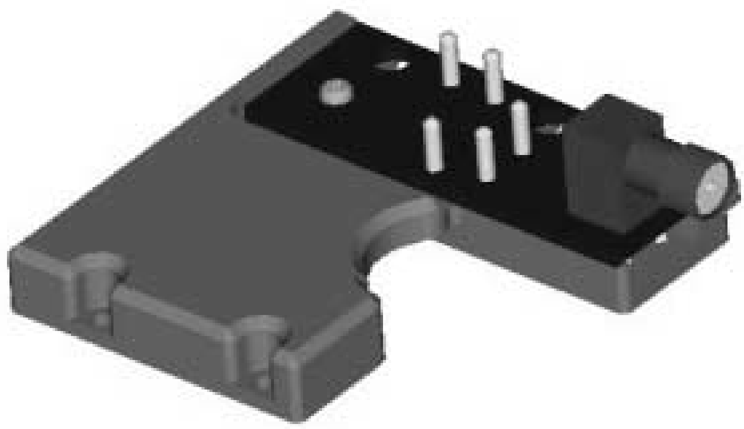
RA7 RF adater is low cost option for NHL-2 RF tuning. RA7 can be used together with FLA-21 or MJF-7/JBV-1 combination. Four screws has to be opened in NHL-2 Transceiver and Acoustic chamber has to be removed in order to be able to use RA7 RF adapter.

## Product Code

| | |
|---|---|
| RA7 RF adapter | 0770443 |

## View of RA7 Adapter

**Figure 5: RA7**



# MJS-9Q Module Jig

The MJS-9Q Module Jig is used for testing of the following modules:

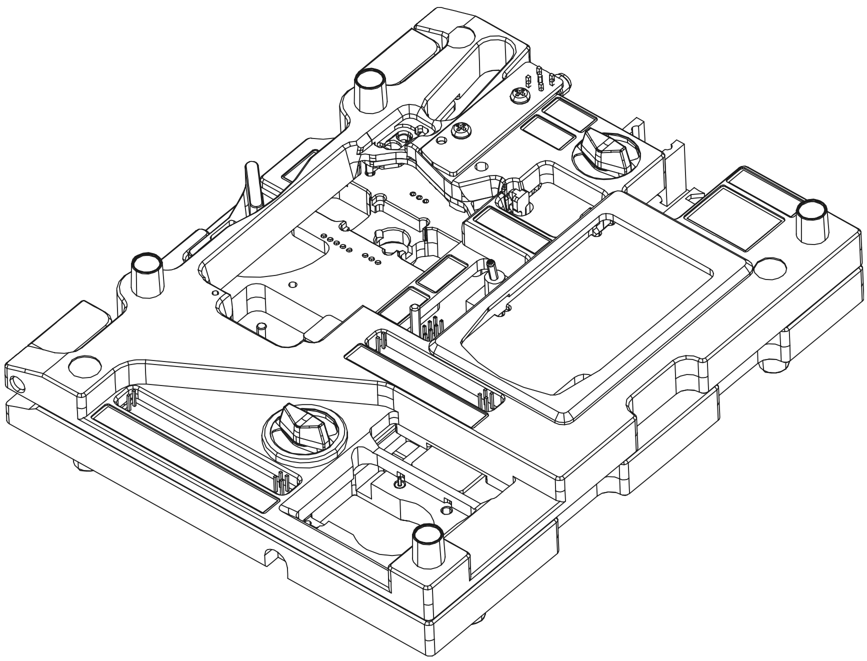
- User Interface
- Baseband on LG4 module
- RF on LG4 module
- Grip module

## Product Code

MJS-9Q Module Jig: 0775284

## View of MJS-9Q

**Figure 6: MJS-9Q**



*Note: The nominal supply voltage for MJS-9Q is +6.0 V. The supply voltage must not exceed +9.0 V (min 5V).*

# MJS-79 Soldering Jig

The Soldering Jig MJS-79 is used for soldering and as a rework jig for system module.

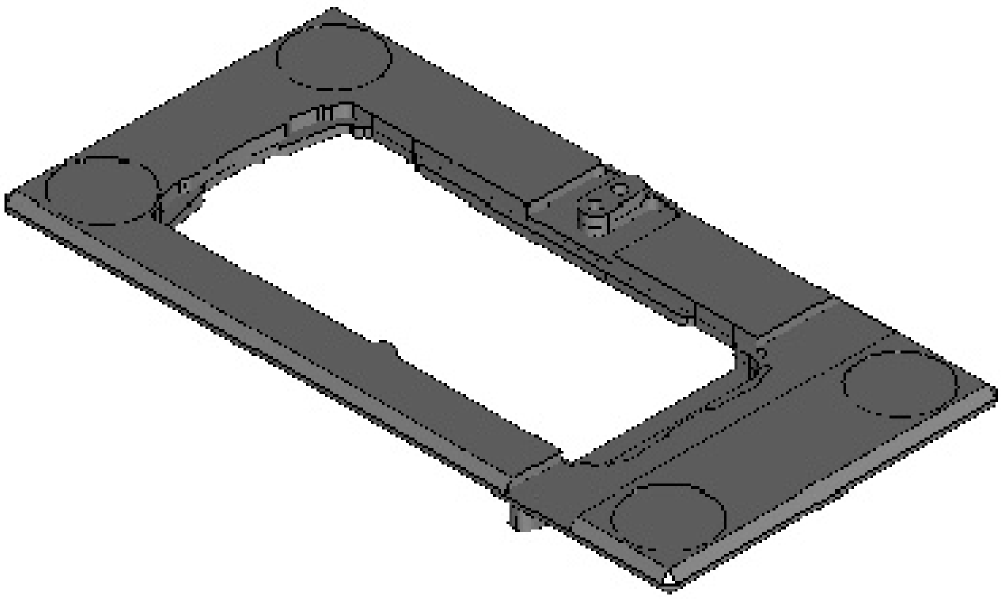
## Product Code

MJS-79 Module Jig: 0770439

## View of MJS-79

Picture will be added here later.

**Figure 7:**



# LRK-1 Rework Kit

The LRK-1 Rework Kit  is used for PA Chip (LGA type component) rework and includes Rework Jig MJS-54, SES-1 Stencil and SPS-1 Soldering Paste Spreader.

The sales pack includes:

| | |
|---|---|
| MJS-54 Rework Jig: | 0770349 |
| SES-1 Stencil: | 0770348 |
| SPS-1 Soldering Paste Spreader: | 0770381 |

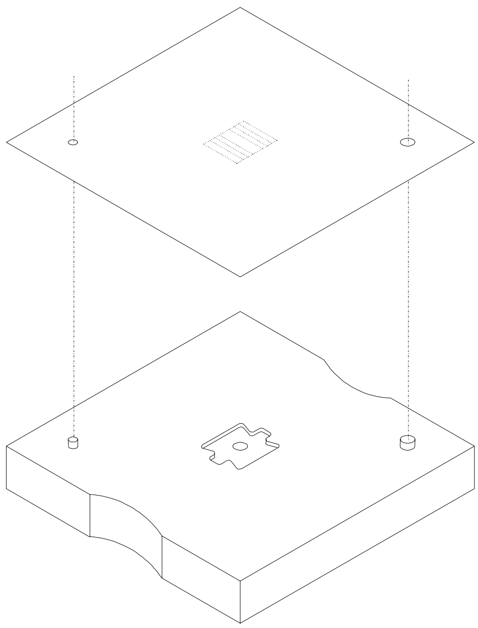
Note: Not included in sales package.
SPI- 1 Soldering Paste Injector 0770380

## Sales package code

LRK-1 Rework Kit: 0080465

## View of MJS-54 and SES-1

**Figure 8: MJS-54 and SES-1**



# LS4 to LG4 Flex change soldering head

Special soldering head is required to change flex which is soldered to LG4 main PWB. Soldering head does not have type designation or NMP code, it has to be ordered directly from Metcal.

## Sales package code

Sales package code: No NMP Code, Metcal order code is SMTC-163.

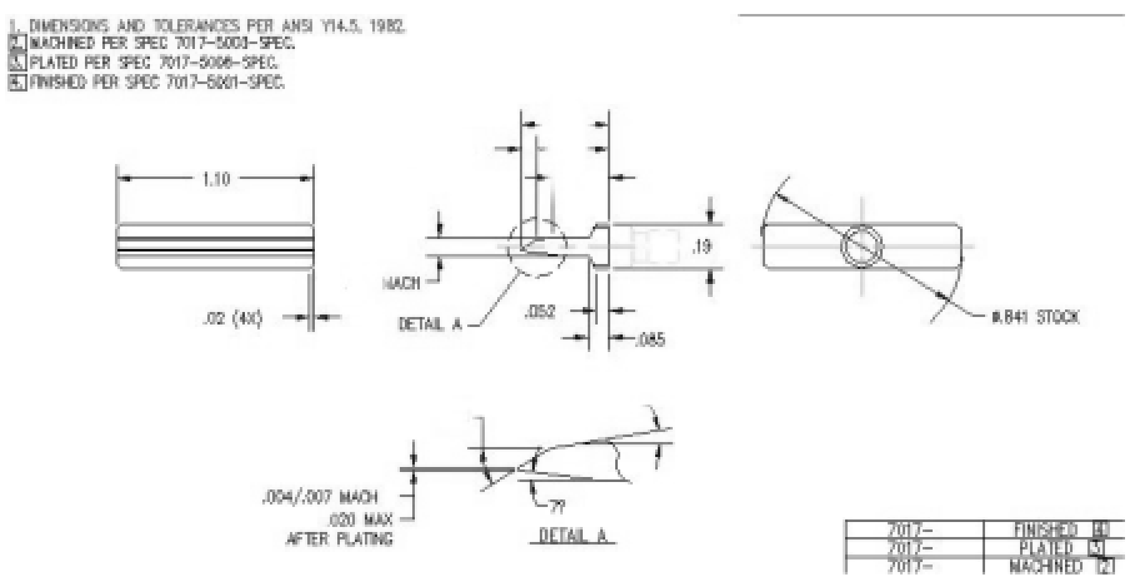
The tip can be ordered from Metcal distributors in all European countries, in South Africa, Australia and in the following Asian countries:

- India
- China
- Korea
- Japan
- Taiwan
- Singapore
- Malaysia
- India

See contact information in: http://www.metcal.com/distributors/

## View of Soldering Tip

**Figure 9: Soldering Tip**



# FPS-8 Flash Prommer (Sales Pack)

The Flash Prommer FPS-8 is used with e.g. FLA-21 and JBV-1. Power is supplied to FPS-8 from the Universal Power Supply.

The sales pack includes:

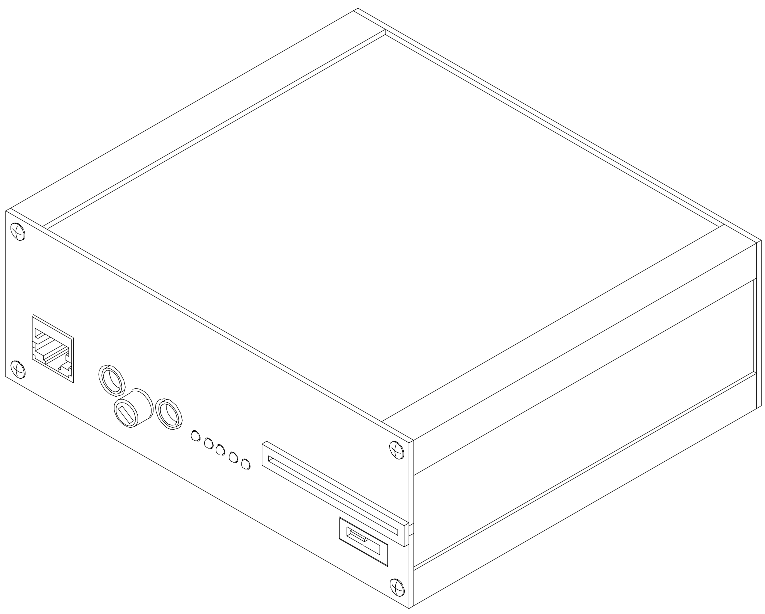
| | |
|---|---|
| - FPS-8 Flash Prommer | 0750123 |
| - FPS-8 Activation Sheet | 9359289 |
| - Universal Power Supply | 0680032 |
| - AXS-4 Service Cable (D9-D9) | 0730090 |
| - Printer cable | 0730029 |

## Sales package code

FPS-8 Flash Prommer: 0080321

## View of FPS-8

**Figure 10: FPS-8**



# SF12 SRAM module for FPS-8

FPS-8 flash prommer has to be equipped with 2 pcs of SF12 memory modules in order to update SW into NHL-2NA product.

## Sales package code

SF12 SRAM module for FPS-8: 0080346

## View of SF12

Picture of SF12 module is available in FPS-8 flash concept picture in NHL-2NA service manual.

# FPS-8C Parallel Flash Prommer (Sales Pack)

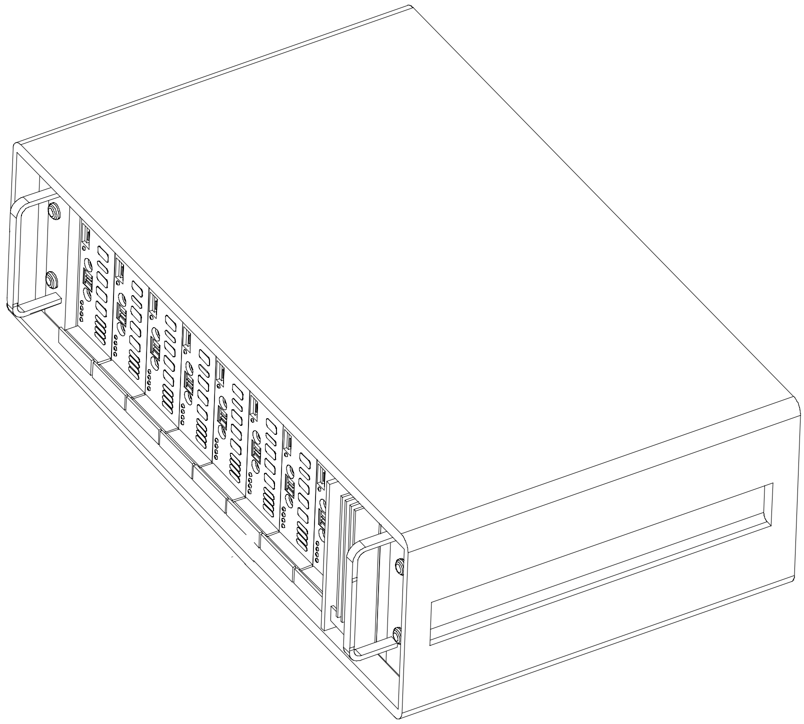
The Parallel Flash Prommer FPS-8C is used with MJF-6 and JBV-1. Flash programming can be done to maximum of 8 phones parallel. FPS-8C consists of eight SF11C programming cards. SF11C card is functionally identical to FPS-8.

## Sales package code

FPS-8C Parallel Flash Prommer: 0080396

## View of FPS-8C

Figure 11: FPS-8C



# ACF-8 Universal Power Supply

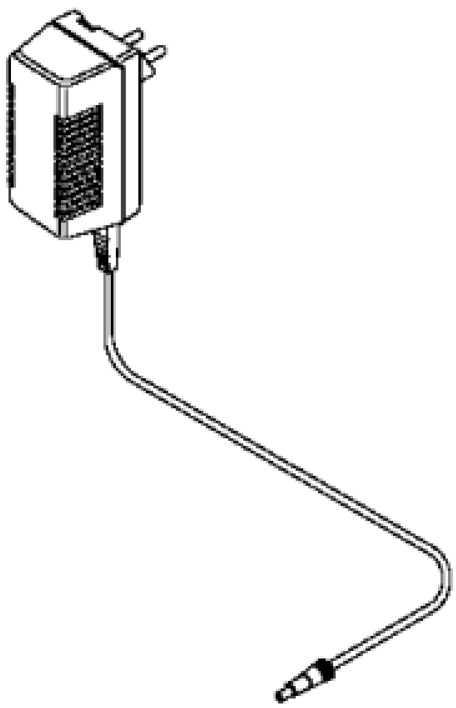
ACF-8 Universal Power Supply is used to power FPS-8. ACF-8 has 6 V DC and 2.1 A output.

## Product Code

ACF-8 Universal Power Supply: 0680032

## View of ACF-8

Figure 12: ACF-6



# FLA-21 POS (Point Of Sale) Flash Loading Adapter

The POS Flash Loading Adapter FLA-21 is used in place of the phone's normal battery during service, to supply a controlled operating voltage and to connect to pads which are located between tranceiver and grip part. Note! Phone has to be opened into special service position with SRT-4 and SRT-5 tools in order to be able to used FLA-21 POS flash adapter.

## Product Code

FLA-21 POS Flash Loading Adapter: 0775283

## View of FLA-21

Figure 13: FLA-21

# SRT-4 Opening tool (Upper part)

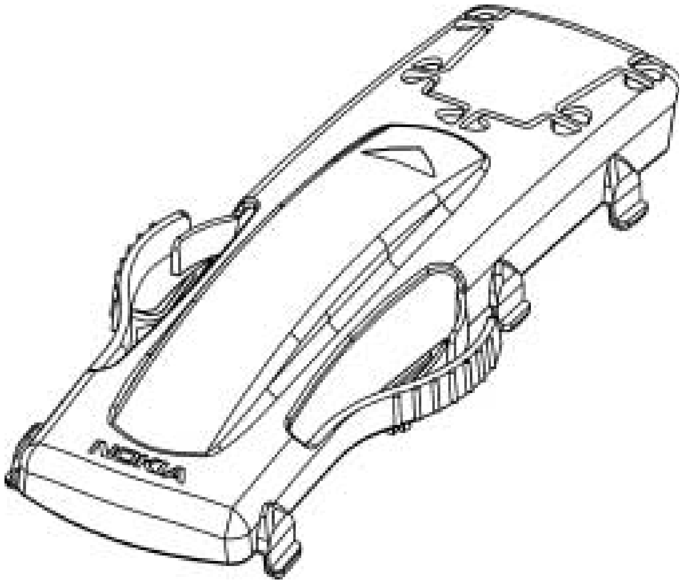
STR-4 opening tool is used together with SRT-5 tool to get NHL-2 tranceiver into position where FBUS and MBUS pads are visible. If end part of SRT-4 is cut away, it can also be used for complete disassembly of the phone.

## Product Code

SRT-4 Opening tool (Upper part)0770286

## View of SRT-4

Figure 14: SRT-4



# SRT-5 Opening Tool (Lower part)

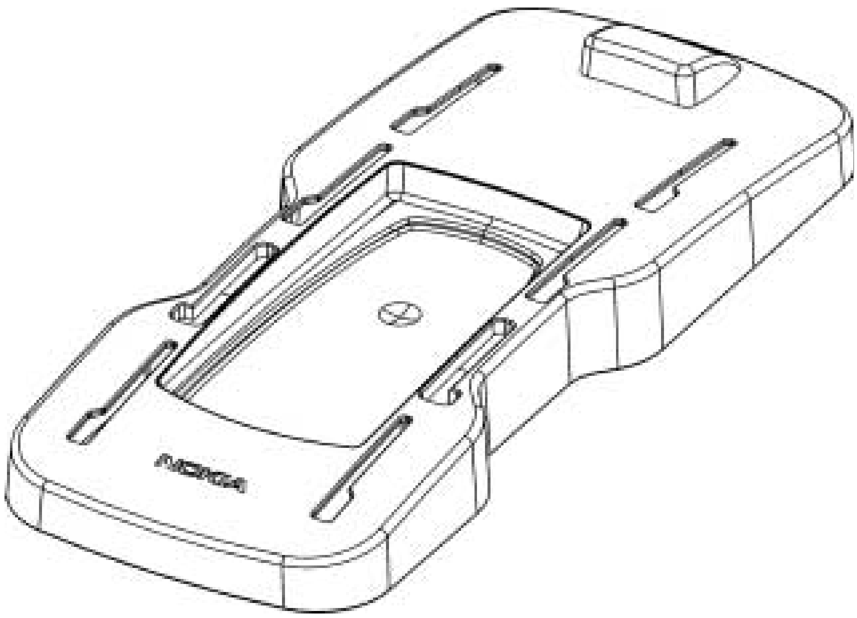
STR-5 opening tool is used together with SRT-4 tool to get NHL-2 tranceiver into position where FBUS and MBUS pads are visible.

## Product Code

SRT-5 Opening tool (Lower part)0770444

## View of SRT-5

**Figure 15: SRT-5**



# SRT-6 Opening Tool

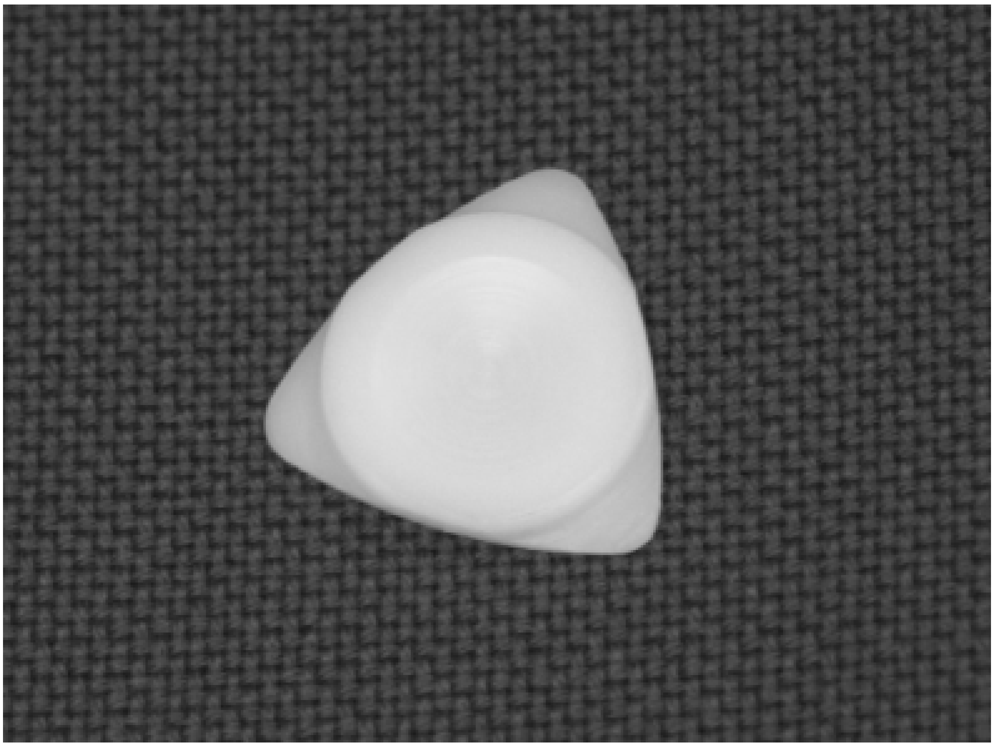
STR-6 opening tool is used to completely disassemble NHL-2NA product. It must be used to detach flex cable from grip part and to remove A-cover.

## Product Code

| | |
|---|---|
| SRT-6 Opening tool | 0770431 |

## View of SRT-6

Figure 16: SRT-6



# FLC-2 DC Cable

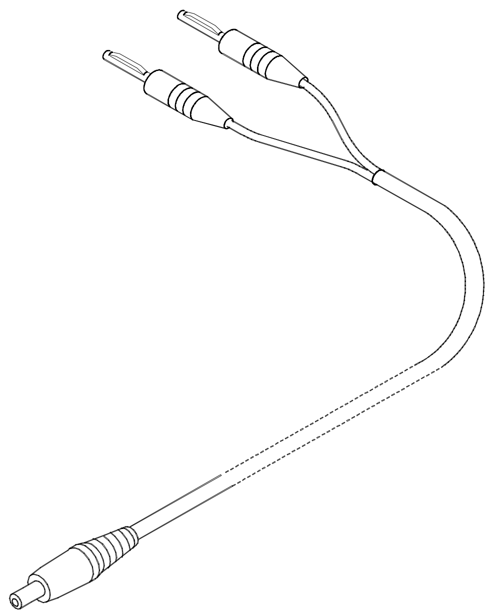
The FLC-2 is used to supply a controlled operating voltage to FLA-21 adapter.

## Product Code

| | |
|---|---|
| FLC-2 DC Cable: | 0730185 |

## View of FLC-2

**Figure 17:**



# AXS-4 Service Cable

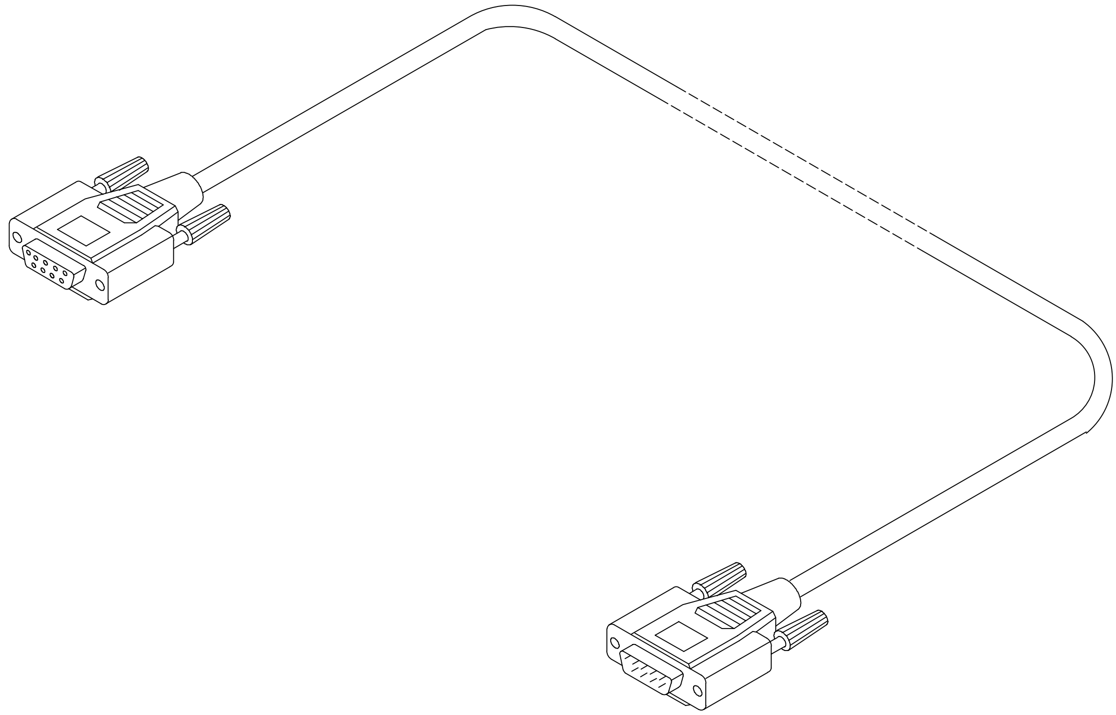
The AXS-4 D9-D9 Service Cable is used to connect two 9 pin D connectors e.g. between PC and FPS-8. Cable length is 2 meters.

## Product code

| | |
|---|---|
| AXS-4 D9-D9 Service Cable: | 0730090 |

## View of AXS-4

Figure 18: AXS-4



# XCS-1 Service Cable

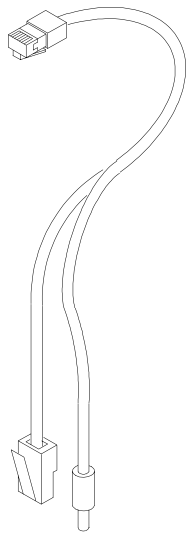
The XCS-1 Service Cable is used to connect FLS-4 to FLA-21.

## Product code

XCS-1 Service Cable: 0730218

## View of XCS-1

**Figure 19: XCS-1**



# SW Security Device PKD-1

SW security device is a piece of hardware enabling the use of the service software when connected to the parallel (LPT) port of the PC. Whithout the dongle present it is not possible to use the service software. Printer or any such device can be connected to the PC through the dongle if needed.

Caution: Make sure that you have switched off the PC and the printer before making connections!

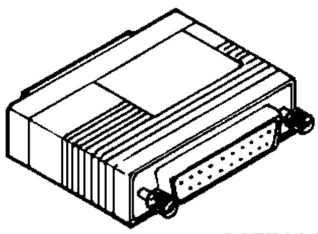
Caution: Do not connected the PKD-1 to the serial port. You may damage your PKD-1!

## Product Code

SW Security Device PKD-1: 0750018

## View of SW Security Device

Figure 20: PKD-1



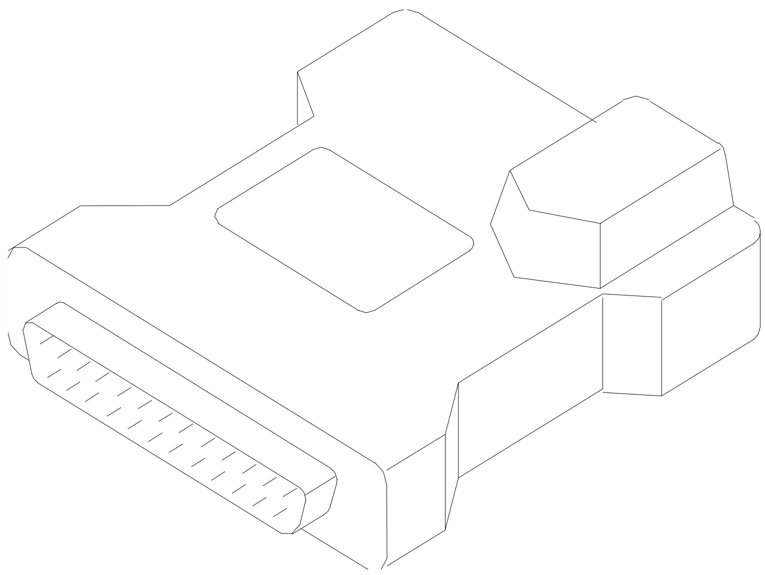
# FLS-4S POS (Point Of Sale) Flash Device (Sales Pack)

FLS–4S is a dongle and flash device incorporated into one package, developed specifically for POS use.

## Product Code

| | |
|---|---|
| FLS-4S Sales Pack – Europe/Africa | 0080541 |
| FLS-4S Sales Pack –APAC | 0080542 |
| FLS-4S Sales Pack –Americas | 0080543 |

## View of FLS-4S



# PCS-1 Power Cable

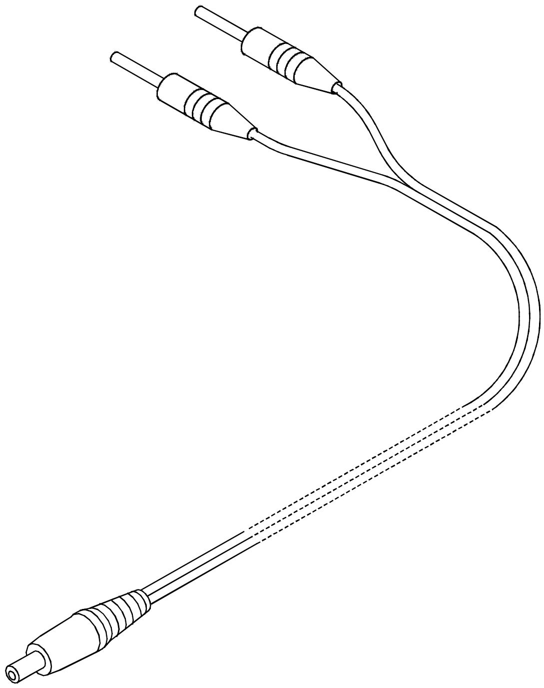
The PCS-1 Power Cable (DC) is used to connect e.g. JBV-1 or MJS-9Q to FPS-8.

## Product Code

| | |
|---|---|
| PCS-1 Power Cable: | 0730012 |

## View of PCS-1

Figure 21: PCS-1



# XRF-1 RF Cable

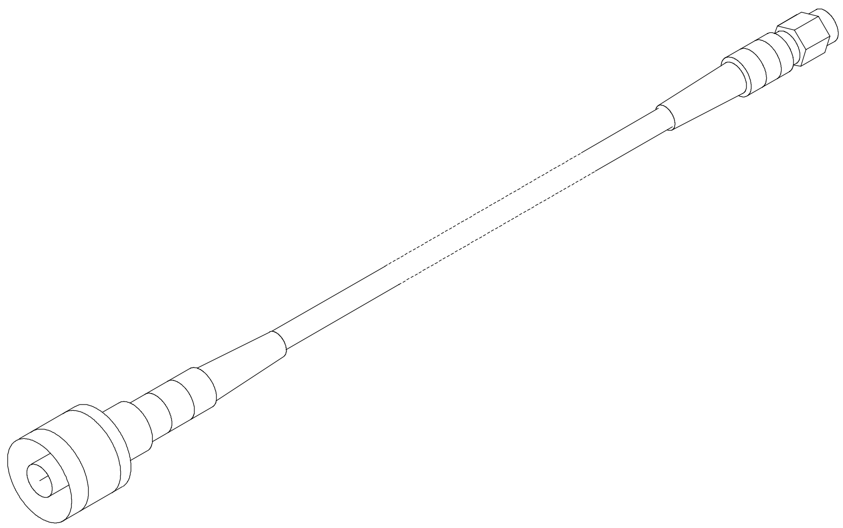
RF cable XRF-1 is used to connect e.g. MJS-9Q, CPL-5, TDS-10 or RA7 to RF measurement equipment..

## Product code

XRF-1 RF Cable: 0730085

## View of XRF-1

**Figure 22: XRF-1**



# DAU-9S MBUS Cable

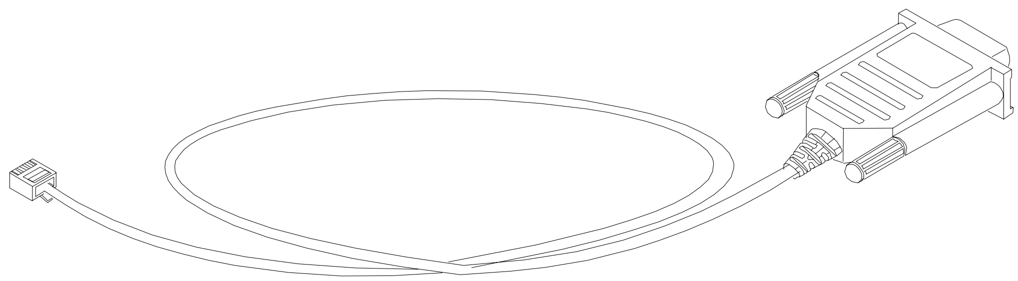
The MBUS Cable DAU-9S has a modular connector, and is used with between PC's serial port and e.g. MJS-9Q, FLA-21, or JBV-1

## Product Code

DAU-9S MBUS Cable: 0730108

## View of DAU-9S

Figure 23: DAU-9S



# SCB-3 DC Cable

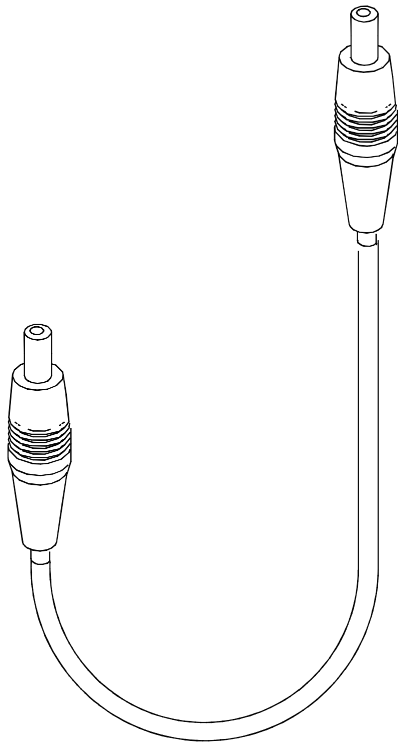
The DC Cable SCB-3 is used to connect e.g. JBV-1 to the phone.

## Product Code

SCB-3 DC Cable: 0730114

## View of SCB-3

**Figure 24: SCB-3**



# XCS-4 Modular Cable

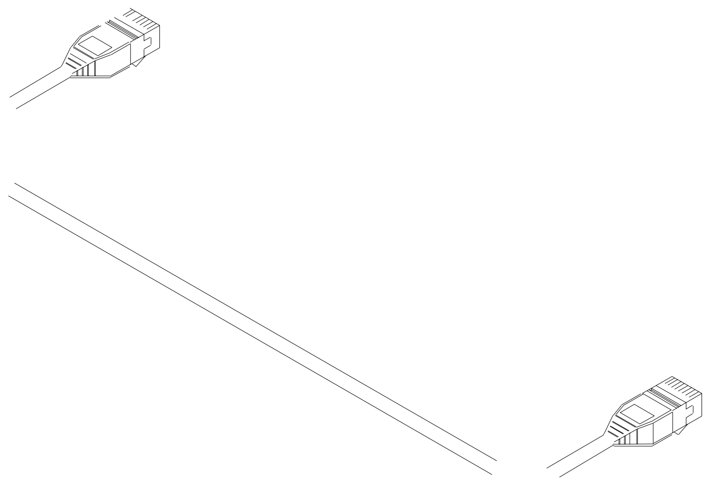
XCS-4 is a shielded cable (one specially shielded conductor) modular cable for flashing and service purposes.

## Product code

XCS-4 Modular Cable: 0730178

## View of XCS-4

**Figure 25: XCS-4**



# Printer Cable

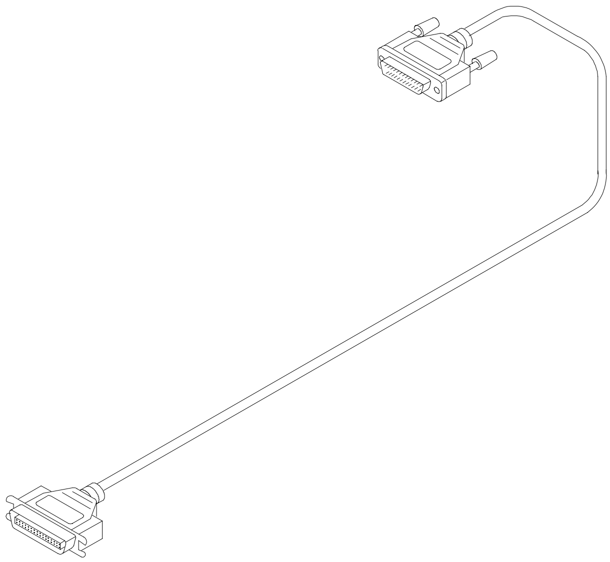
This cable is used to connect the PC to FPS-8.

## Product code

Printer Cable: 0730029

## View of Printer Cable

**Figure 26:**



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# Disassembly Instructions

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## Disassembly jig opened

Install phone onto disassembly jig with grip opened.

*NOTE: Remember to wear gloves or finger covers when working!!*

## Phone with grip opened onto disassembly jig

1 Place the phone onto lower tool cavity upside down.

2 Install upper part on the lower part so that the nails are in the phone tracks.

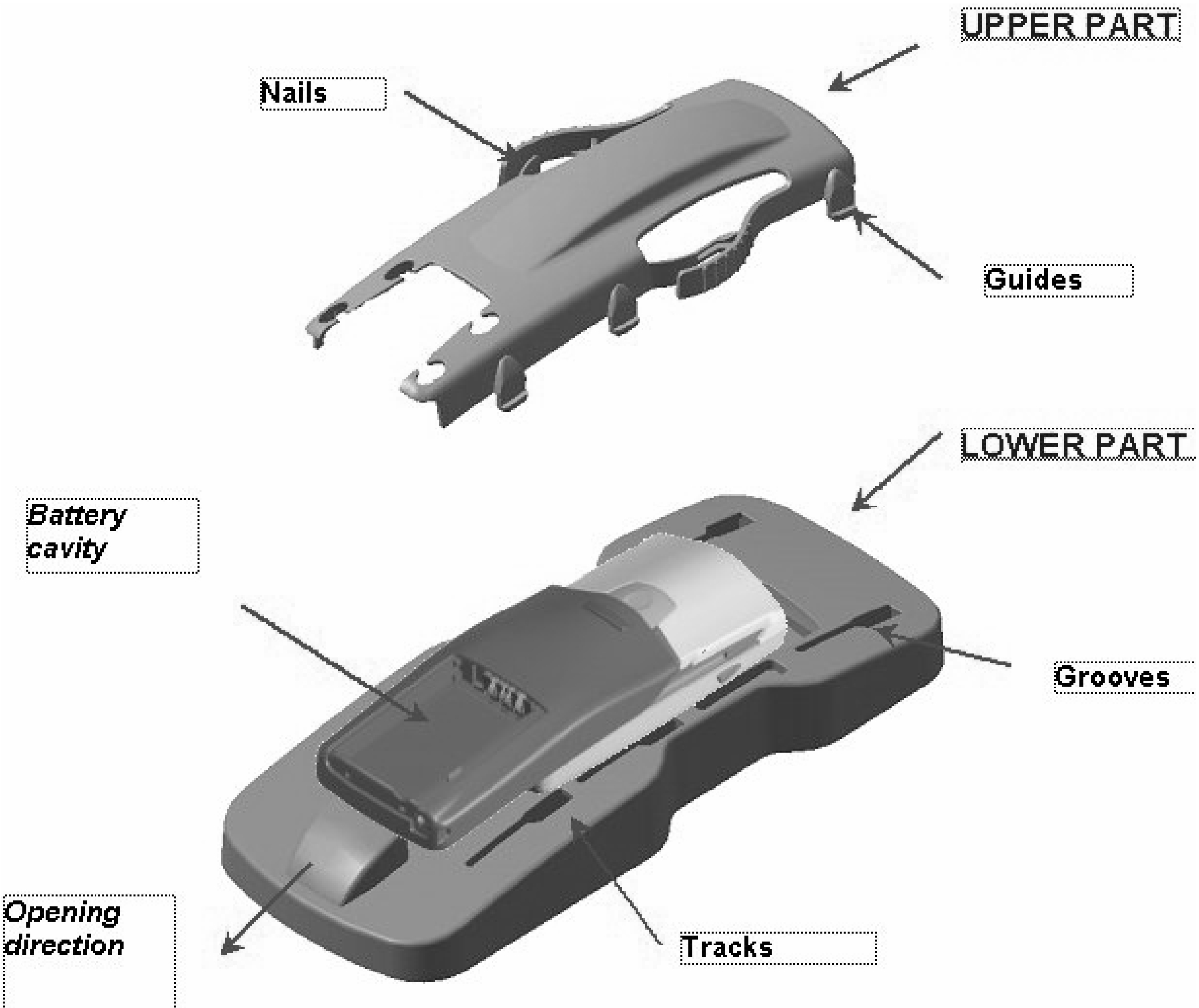
3 And in the same time put the upper part guides to the lower part grooves.

4 Push the upper part till end of the grooves (opening direction).

5 Pull with your thumb from battery cavity to completely disassemble phone.

6 Push the upper part back to the starting point.

7 Remove the upper part.



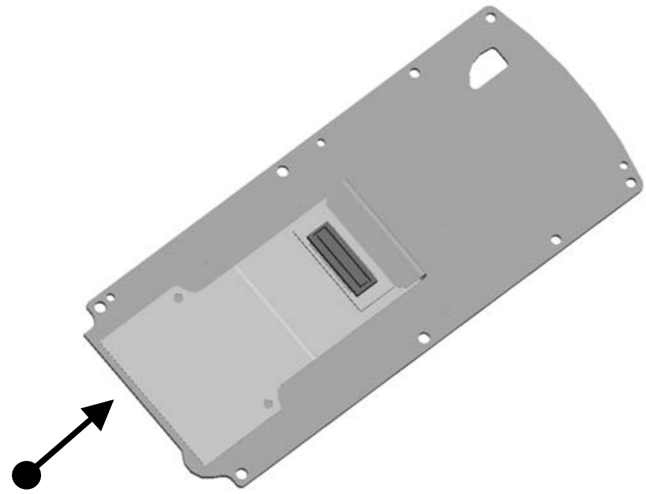
## Push transceiver module to separate module from grip

Be careful when sliding transceiver away from grip module, preventing damage to flex assembly.

Attention:

Be very careful not to break the flex!

Solder joints to main PWB.



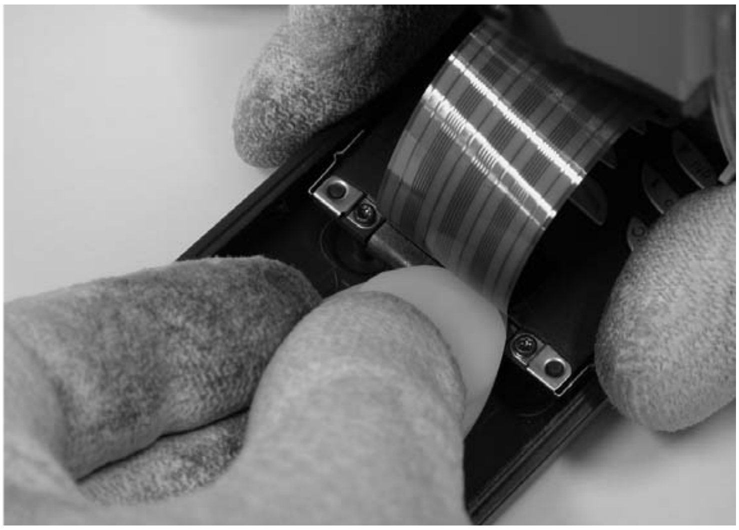
## Protective tape disassembly from grip

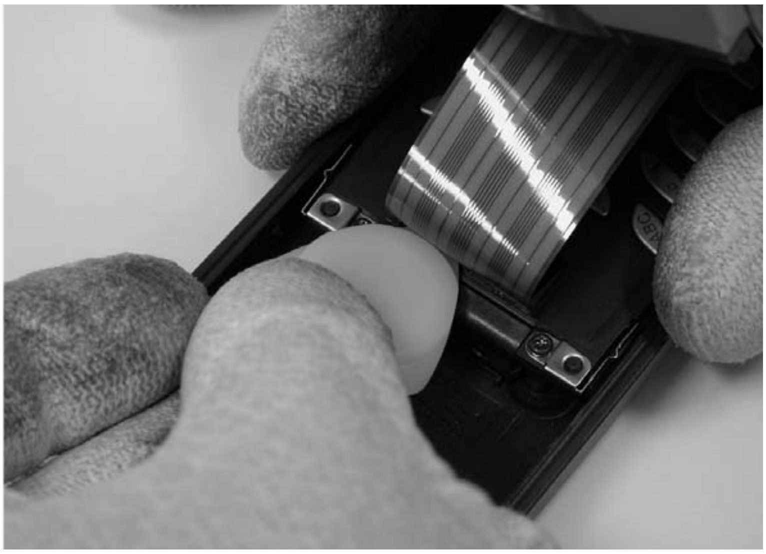
1 Take with tweezers protective tape from one corner and drag the tape away.

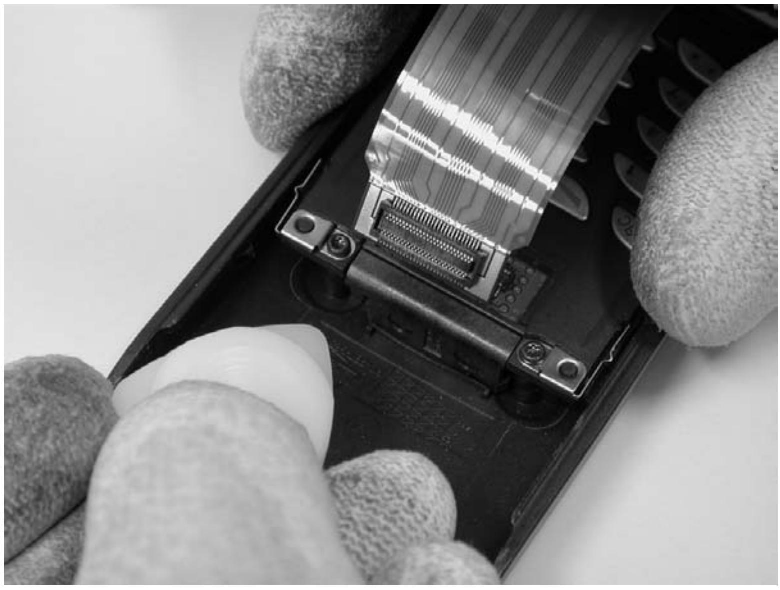
2 At the same time do hold the connector at its place with other hand, preventing-connector to be damaged.


## Flex connector disassembly from grip

1. Take away battery cover.
2. Dismantle battery from transceiver.
3. Take the plastic SRT-6 opening tool.
4. Put one corner under the longer side of connector.
5. Gently rotate the plastic plate first from one side of connector then the other side.
6. Connector will be released from grip.
7. Put Grip module to place where dust cannot reach the module.







**Transceiver module onto jig upside down, removing screws from A-cover and Acoustic chamber.**

1 Take B-cover away from transceiver in hand.

2 Put transceiver onto table.

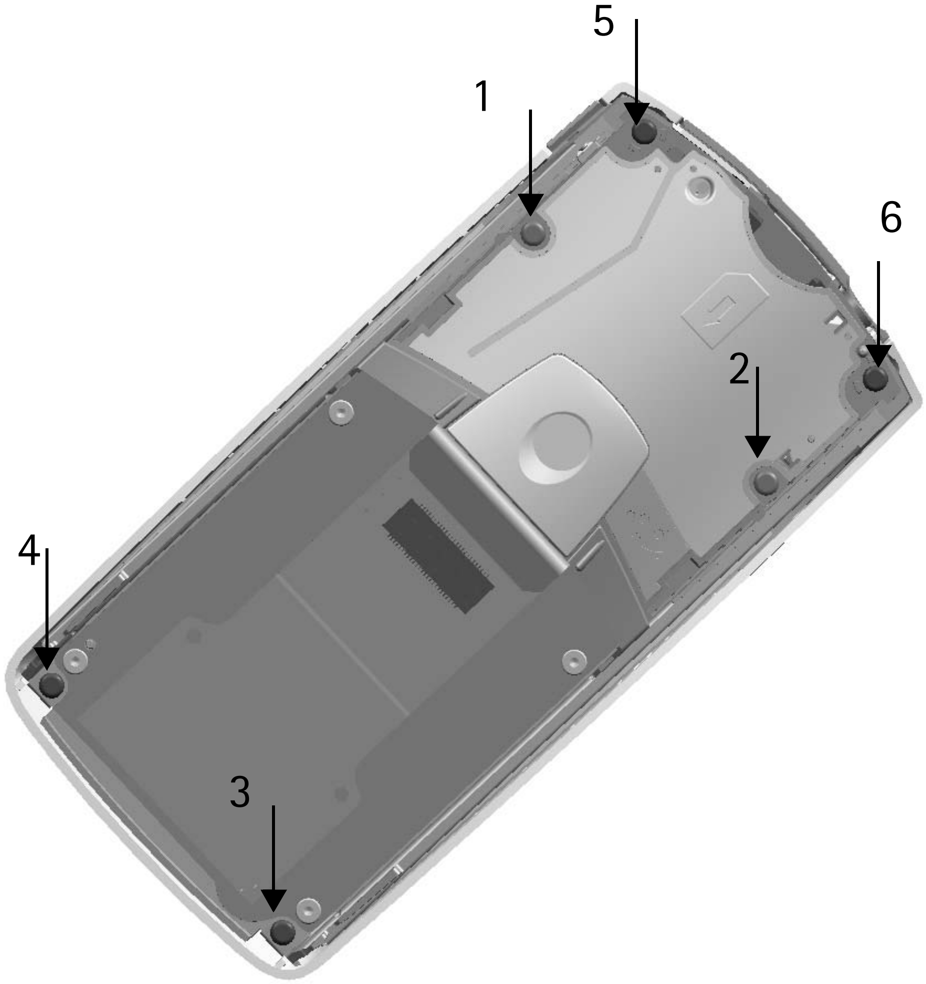
3 Remove screws RF 1,8x8,0 T6+ No. 5,6

4 Remove screws RF 1.8x6.0 T6+ No. 1,2,3,4

*Note: Arrange screws so that you can remember where to place them when assembling.*

5 Remove Acoustic Chamber from transceiver put it to a place where dust cannot reach camera cavity.

Lift from sides!



*Note for assembly! Screws must be tightenend as illustrated in the picture above, correct tightening sequence is 1,2,3,4,5,6.*

1.Screws RFF 1.8x6.0 T6+ to acoustic chamber (2 pcs).

2.Screws RFF 1.8x6.0 T6+ to chassis assembly (2 pcs, bottom corners).

3.Screws RF 1.8x8.0 T6+ to acoustic chamber (2 pcs, top corners).

*Note! If only acoustic chamber is removed and replaced, tightening sequence is then 1,2,5,6.*

## Detaching A-cover from transceiver

1. Take the plastic SRT-6 opening tool put it between the A-cover and chassis assembly from side 1 gently turning the blade.

2. Turning the transceiver upside, separate the A-cover from transceiver in hand.

3. Put transceiver onto jig, attention not to drop UI-module UI-module faces upwards.

**Figure 1: Detaching sequence 1**

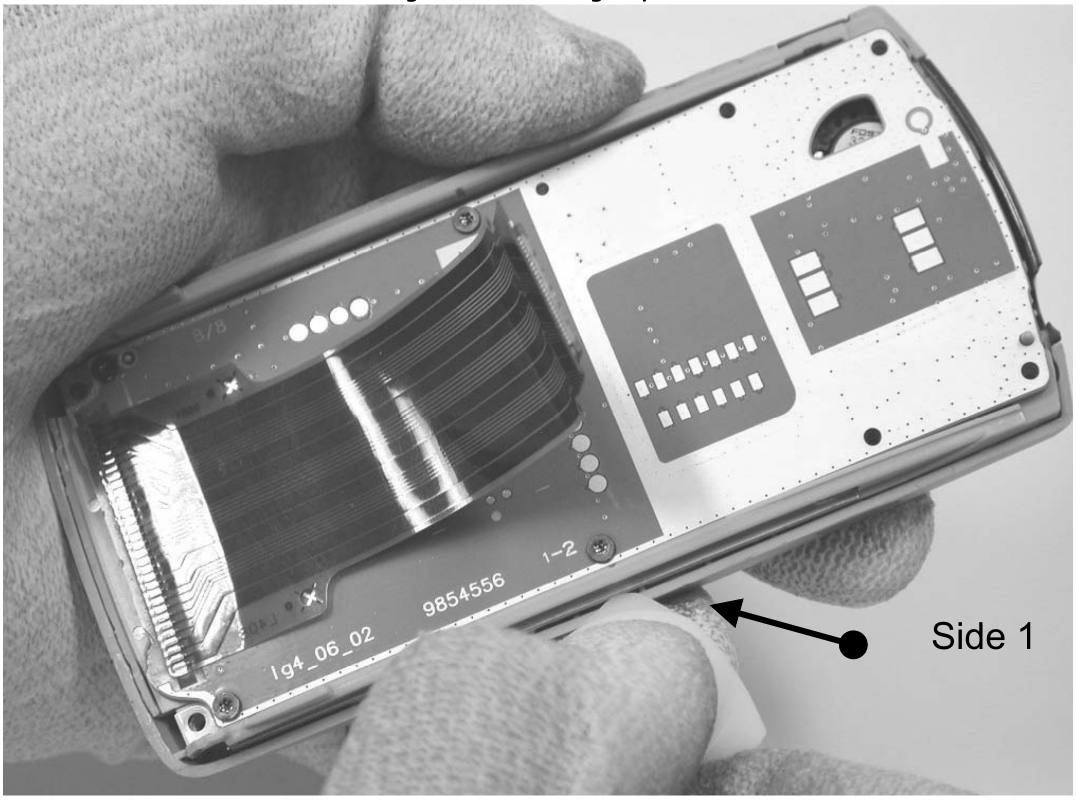


Figure 2: Detaching sequence 2

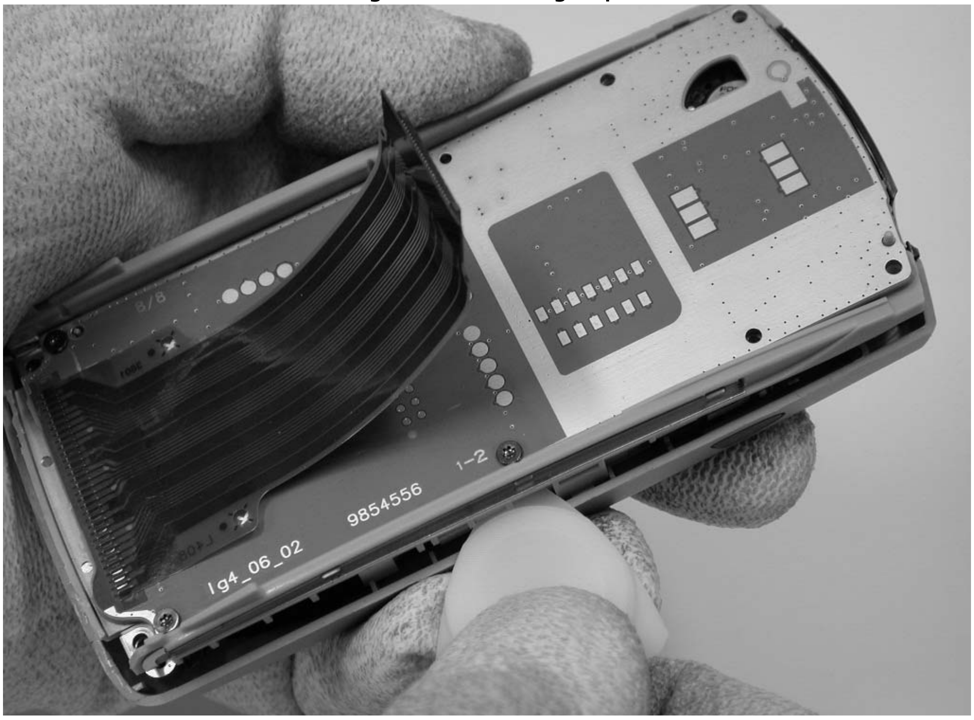
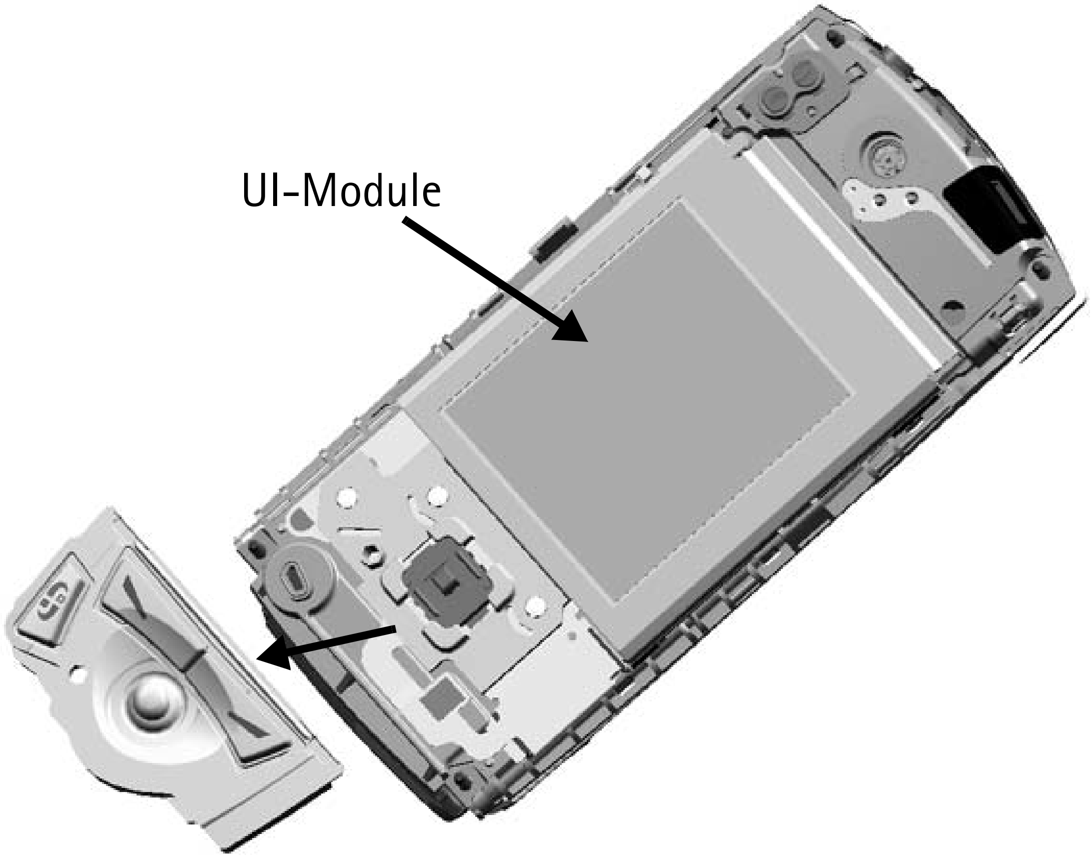



Figure 3: Detaching sequence 3

## Transceiver keymat from transceiver

1 Take away transceiver keymat.

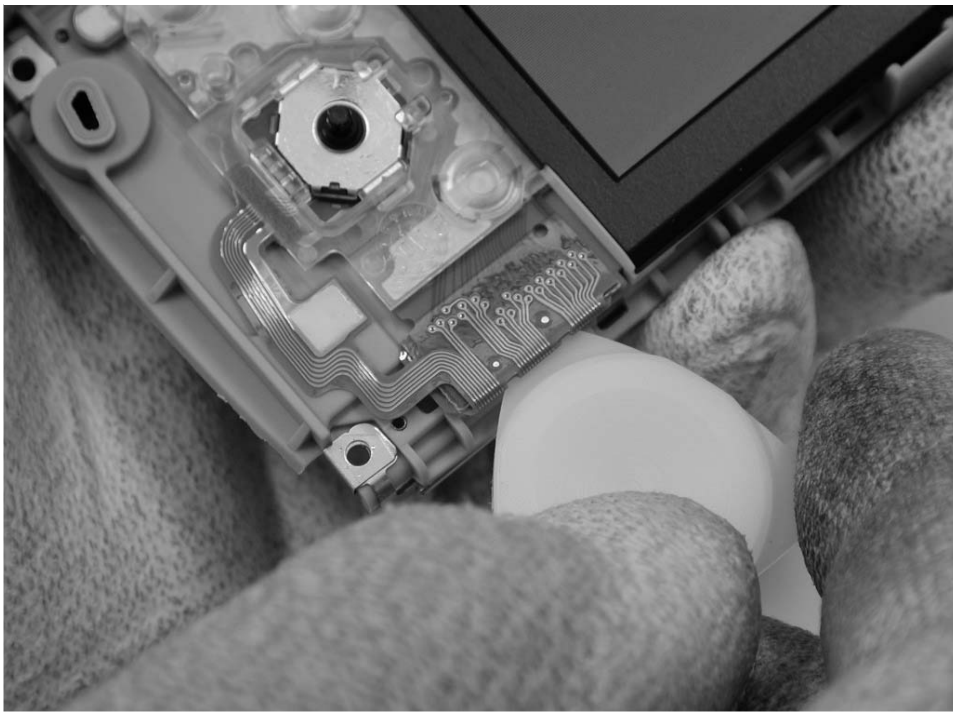
2 Check that inner plastic part (white) of rocker will remain on keymat.



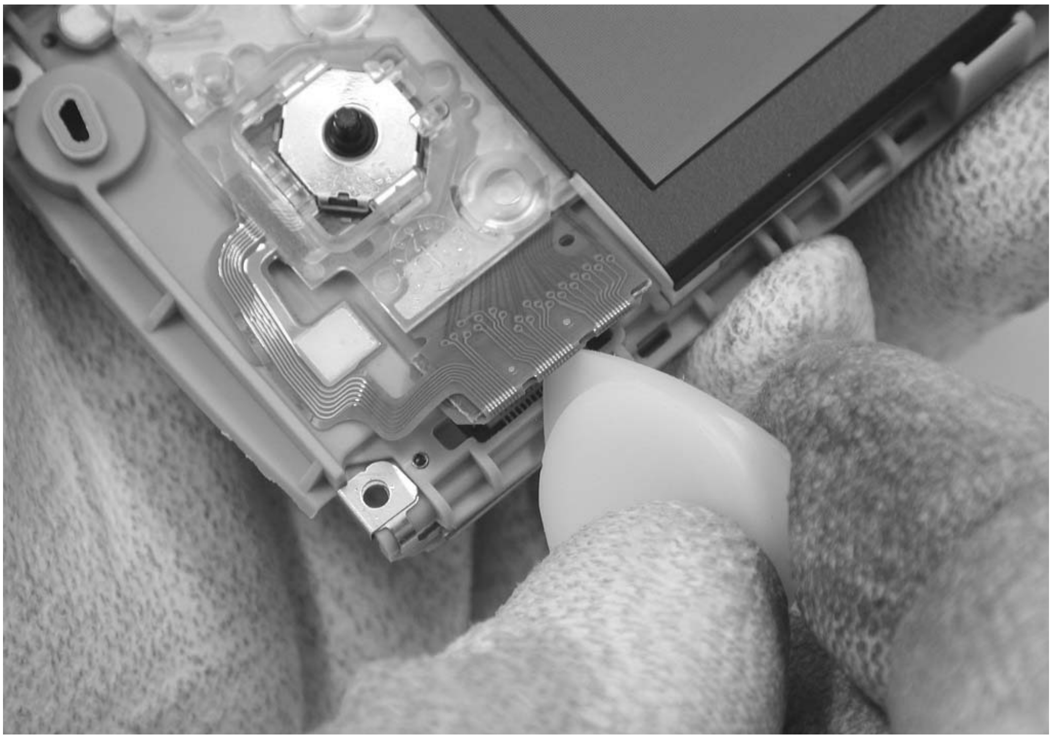
## UI-module B&B connector

1 Use plastic SRT-6 opening tool.

2 Put plastic SRT-6 opening tool under longer side of UI-module connector..



3 Gently separate B&B connector form UI-module by turning the tool



## UI-module from chassis assembly

1 Lift off the UI-module by hand from chassis assembly.

2 Place the UI-module (facing upwards) to a place where dust cannot reach UI-module.

## SIM connector from acoustic chamber

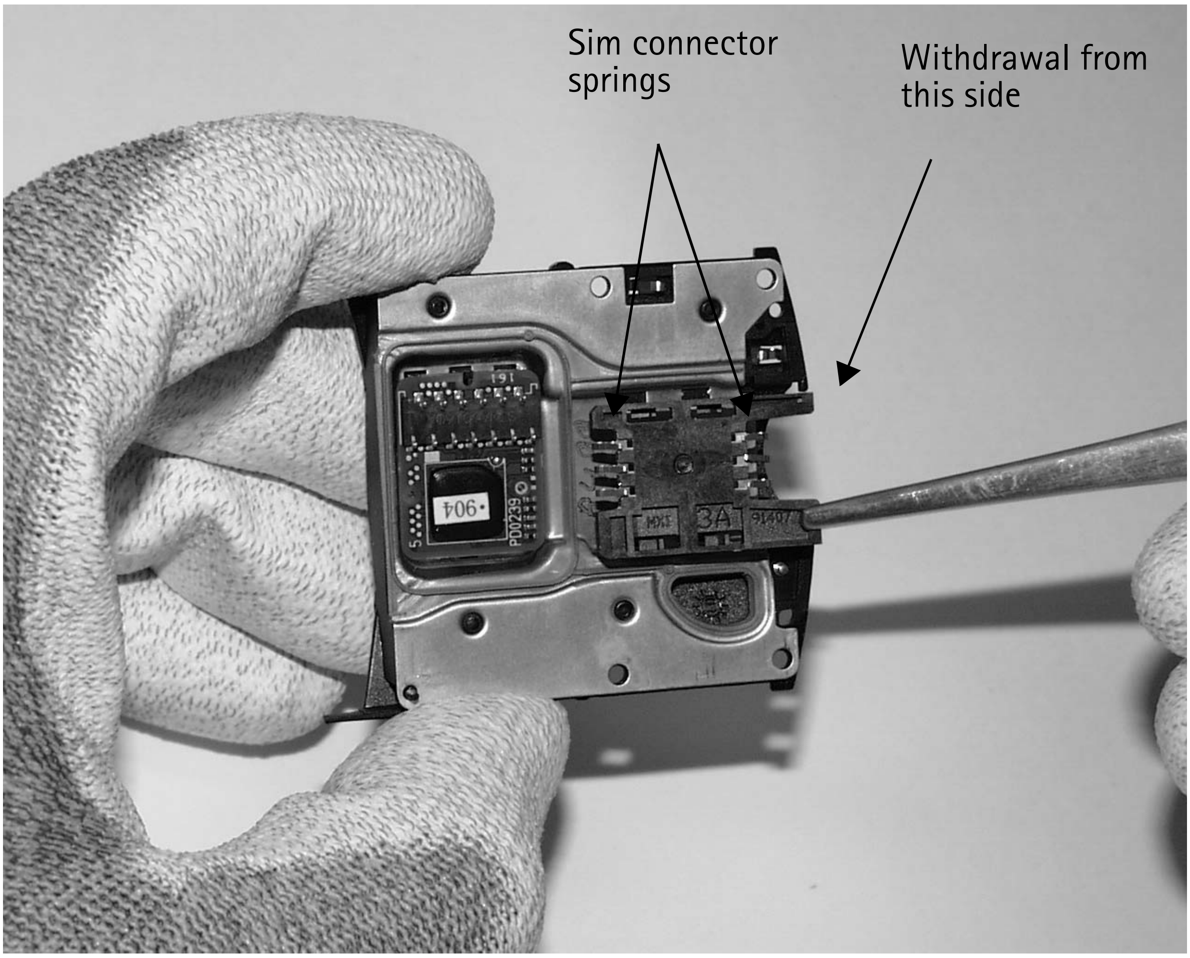
1 Take acoustic chamber to hand.

2 Disconnect the sim connector with tweezers from front side.

3 Withdraw the sim connector from acoustic chamber.

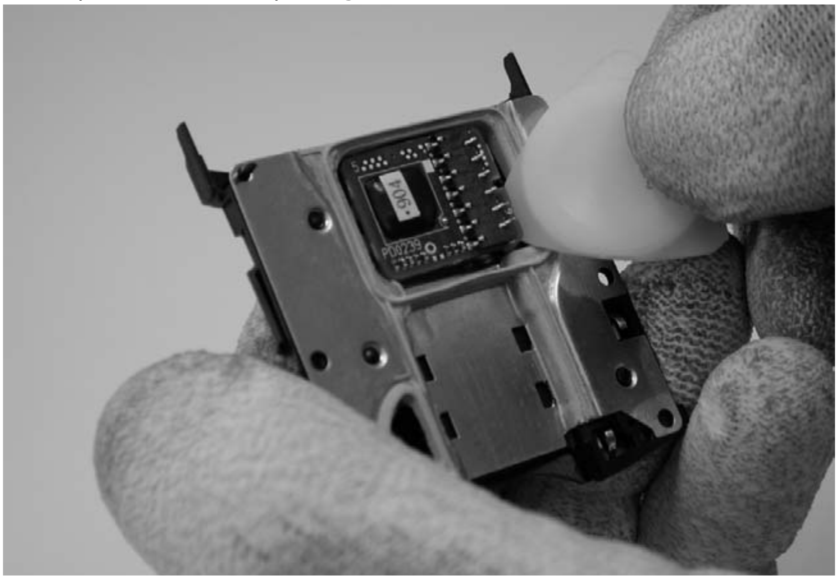
*Note! Sim connector can be loose in its cavity when assembled!*

4 Be careful not to bend springs



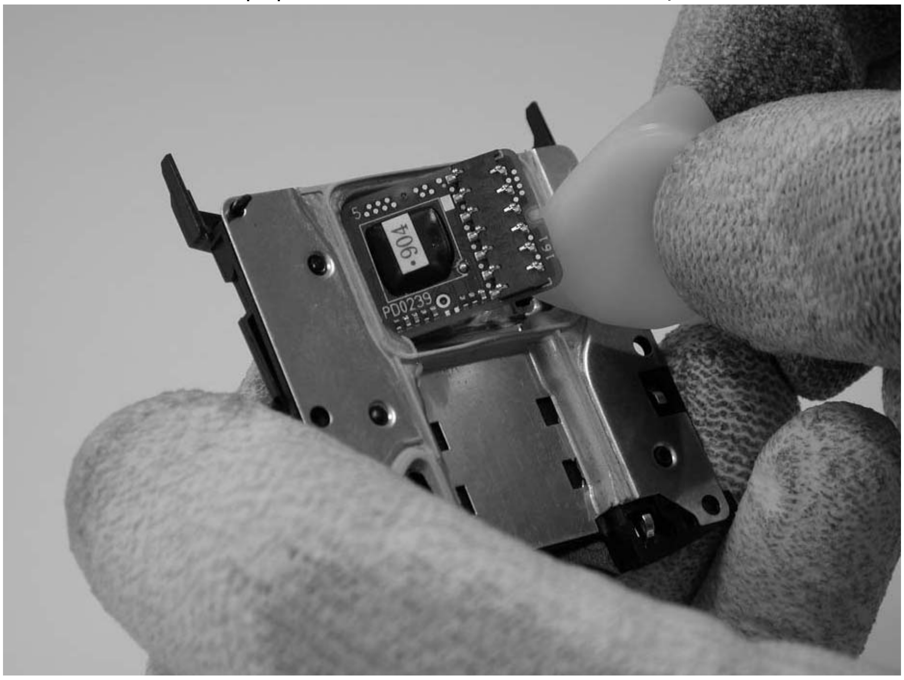
## Camera module from acoustic chamber

1 Put plastic SRT-6 opening tool under the camera PWB



2 With plastic SRT-6 opening tool gently pry out the camera from its housing by turning tool (as in picture)

3 Be careful not to pop out the camera from its cavity.

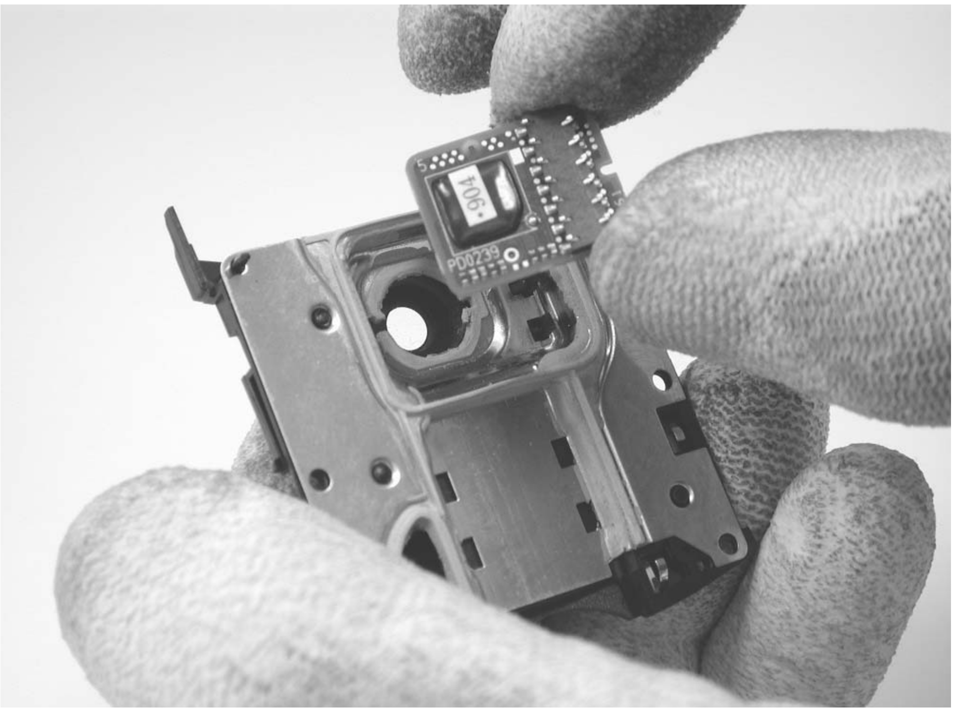


4 Put camera to place where dust cannot access camera module.

5 If gasket is damaged replace acoustic chamber.

6 If guiding pin in acoustic chamber (for camera) is broken replace acoustic chamber.

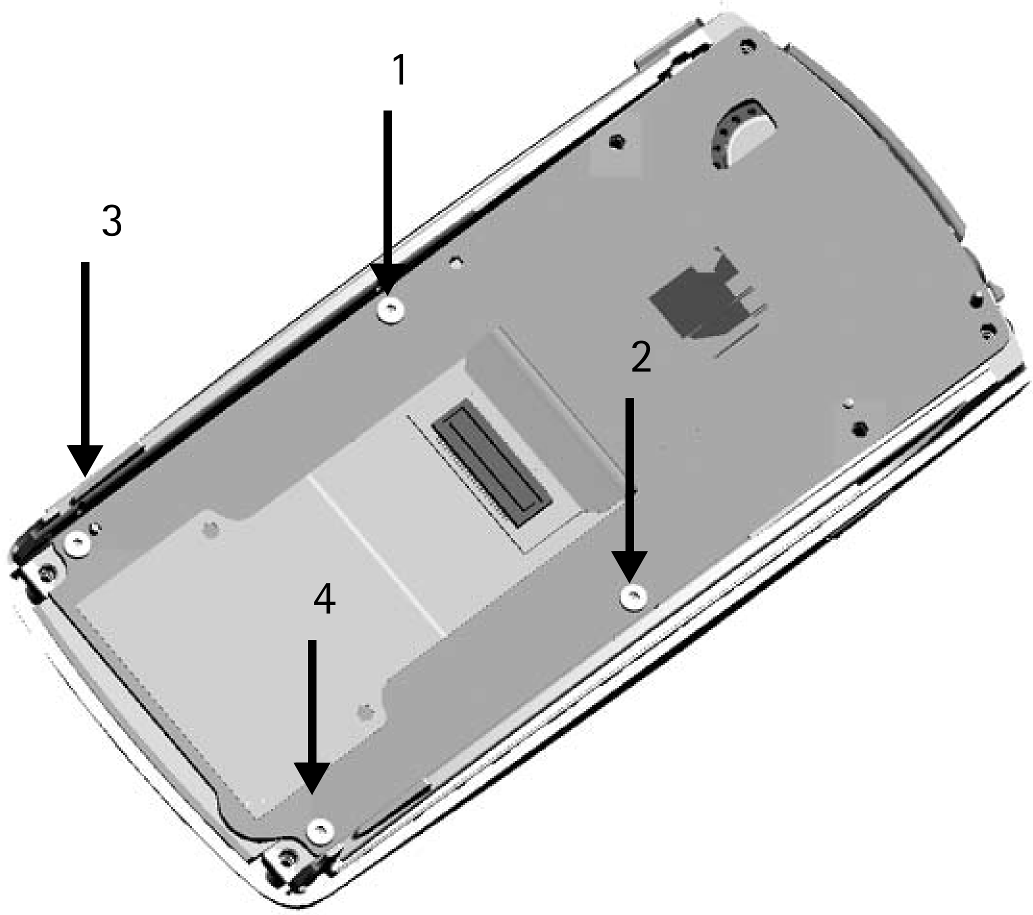
7 Acoustic chamber shall be put to place where dust cannot reach camera cavity.



## Dismantling main PWB from chassis assembly

1 Remove screws RF 1.6x4.4 T5+ 1,2,3,4

*Note: Do not scratch PWB with screwdriving tool.*



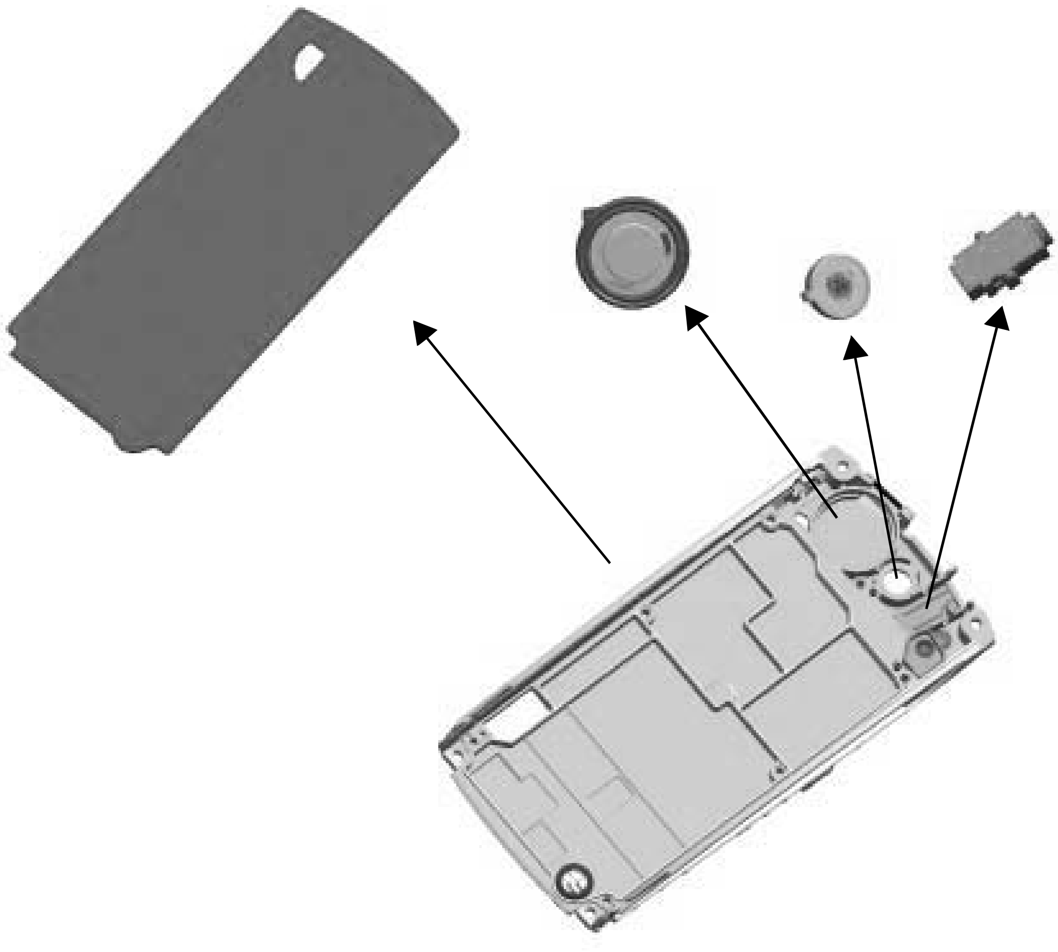

*Note: Assembly sequence for screws is as numbered. 1,2,3,4. Only one step:*

*1. Screws RFF 1.6x4.4 T5+ to Main PWB (4pcs).*

## Main PWB from chassis assembly

1. Take main PWB from chassis assembly by hand and put it onto table.
2. Take Hf-speaker from chassis put it onto table, be careful not to damage spring or membrane.
3. Take earpiece from chassis with earpiece tool put it onto table.
4. Take headset from chassis with tweezers.
5. Microphone can also be removed with a sharp object.

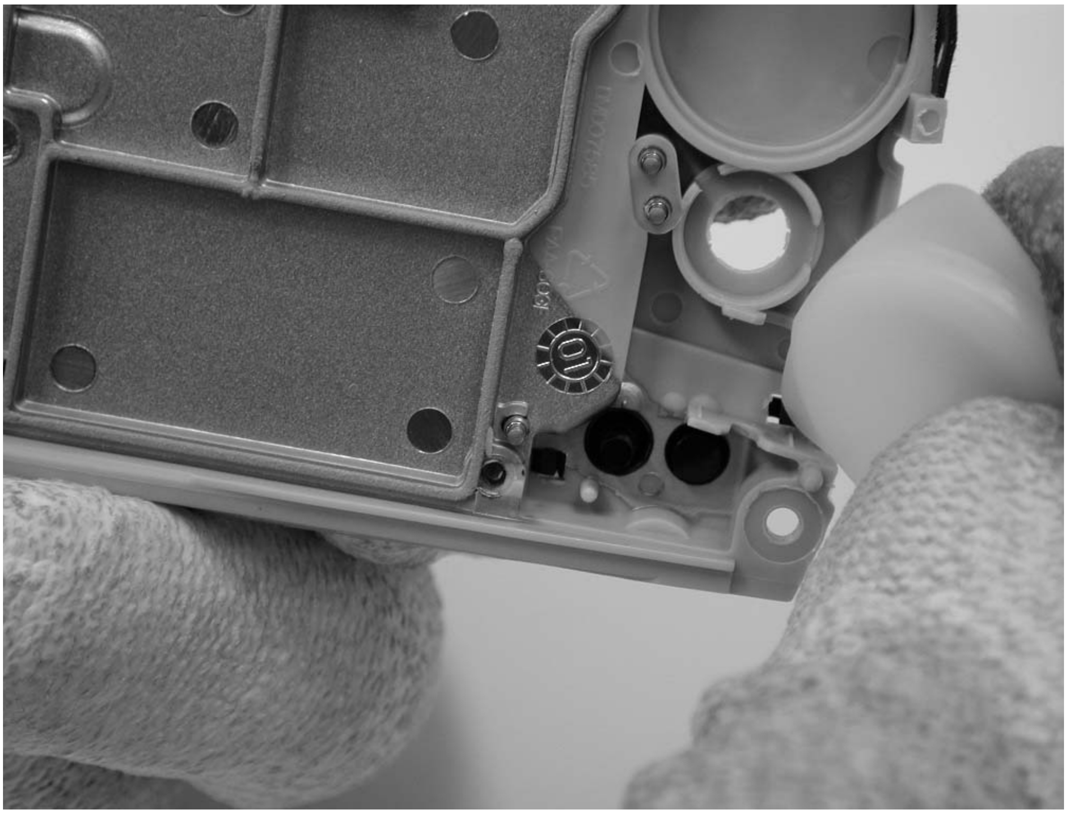
*Note: Magnetism in both HF speaker and earpiece pulls them together so be careful.*



## Proximity sensor from chassis assembly:

1 Use plastic SRT-6 opening tool.

2 Push proximity sensor snap to release it from chassis assembly.



## Proximity sensor from chassis assembly:

1 Lift away proximity sensor

**Power key from chassis assembly:**

1 Use plastic SRT-6 opening tool

2 Push power key downwards to release it from chassis assembly.

## Dismantling keymat cover assembly from grip:

1 Grip to hand; remove screws PT 1.8x8.0 (2pcs). 1,2

2 Put fingers on both sides of battery connector

3 Pull upwards until battery connector is completely free from housing.

4 Slide keymat cover forward to release bottom from Grip.

5 Put Grip on pallet.

1


2,3,4,5

## Dismantling of keymat cover

1 Take keymat cover in hand so that battery connector is facing upwards.

2 Gently pry out the grip pwb Left side (first from upper side then bottom) from keymat cover locking clips. Dismantle grip PWB sliding it to left side direction.

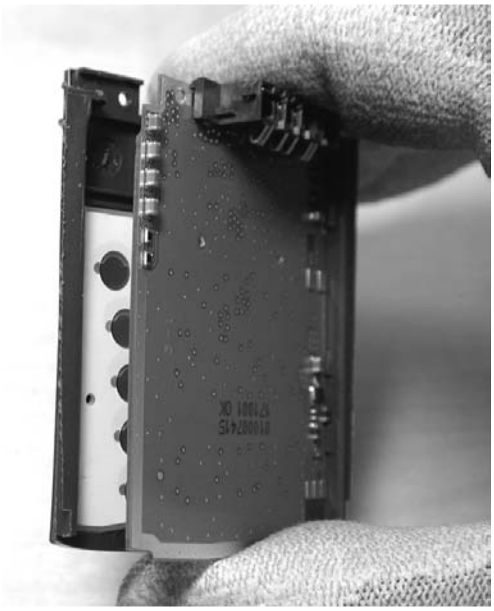
*Note! When assembling grip PWB assemble first right side then left side.*

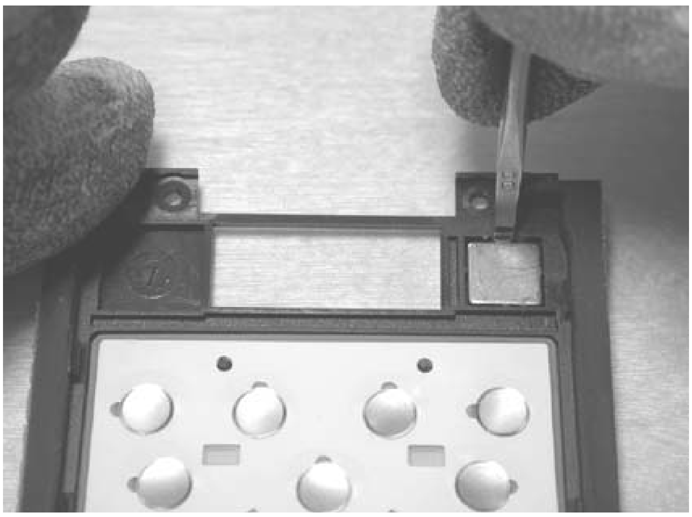
3 Put grip PWB to a dust free place.

4 Lift away keymat from keymat cover.

*Note! If new keymat is assembled remember to take protective tape away from key mat.*

5 Pry out magnet with a sharp tool from keymat cover (be careful not to scratch keymat cover).

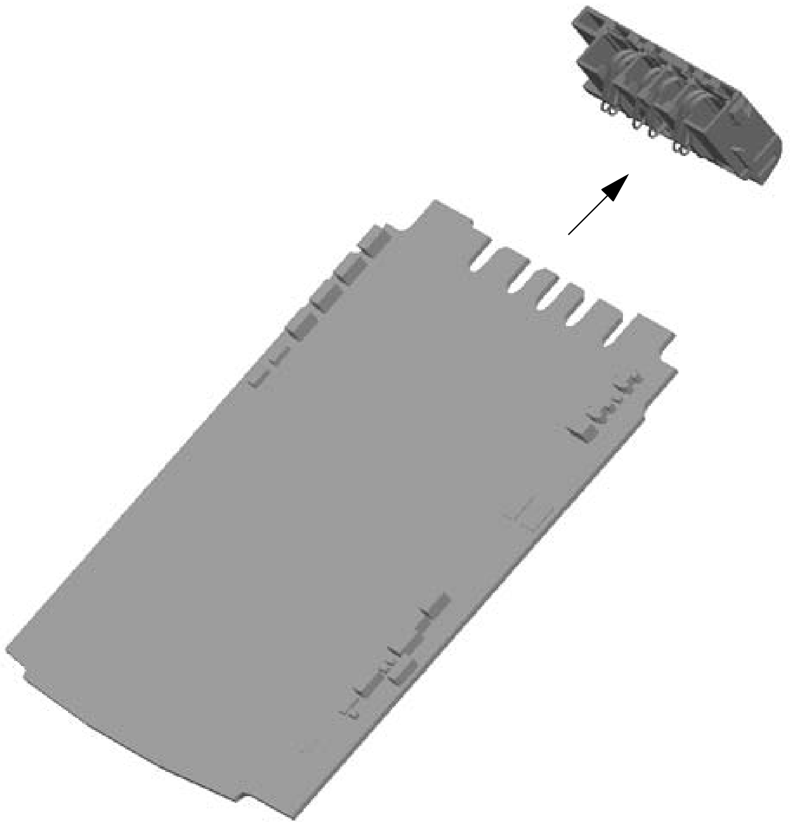




## Dismantling of Battery connector from PWB

1 Take grip PWB in hand so that battery connector is facing to the right side.

2 Withdraw battery connector straight out from grip PWB

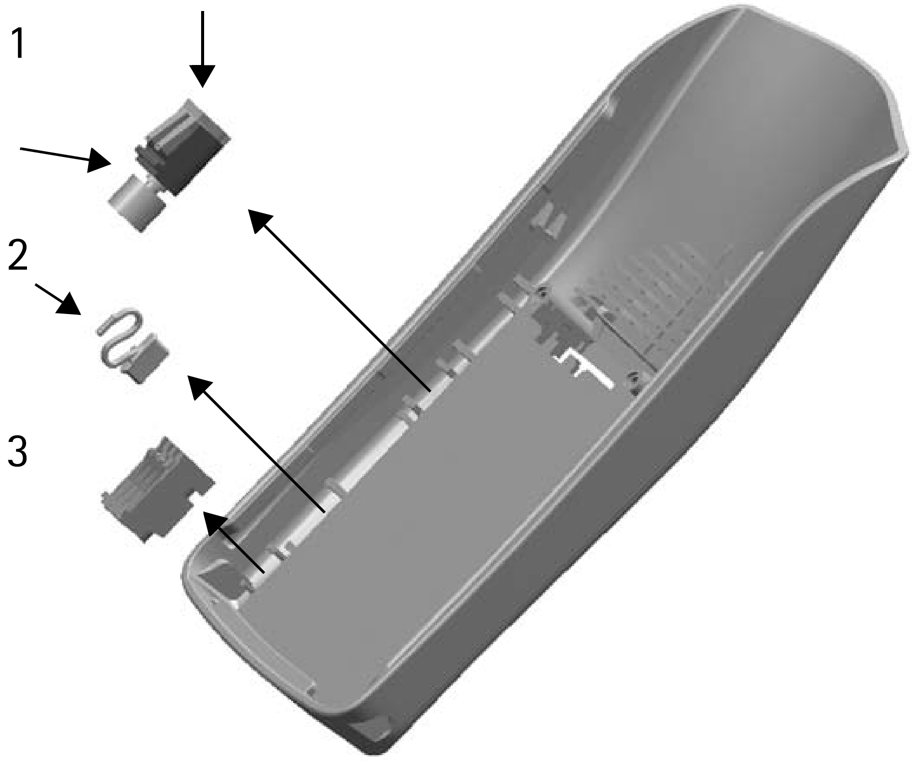


## Take Grip from pallet to hand

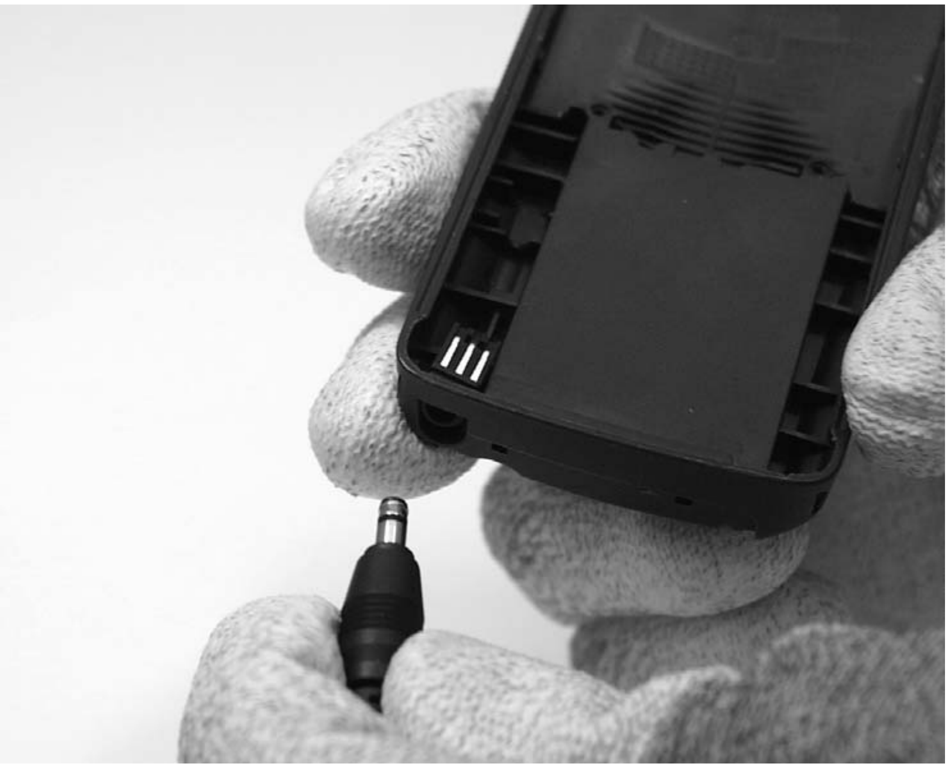
1 With tweezers remove vibra from grip. Grip with tweezers at shorter sides of vibra.

2 Remove with tweezers battery cover locking latch.

3 Connect the charger plug to Dc-jack; carefully pry upwards the Dc-jack from front side. Dc-jack will be released from grip.



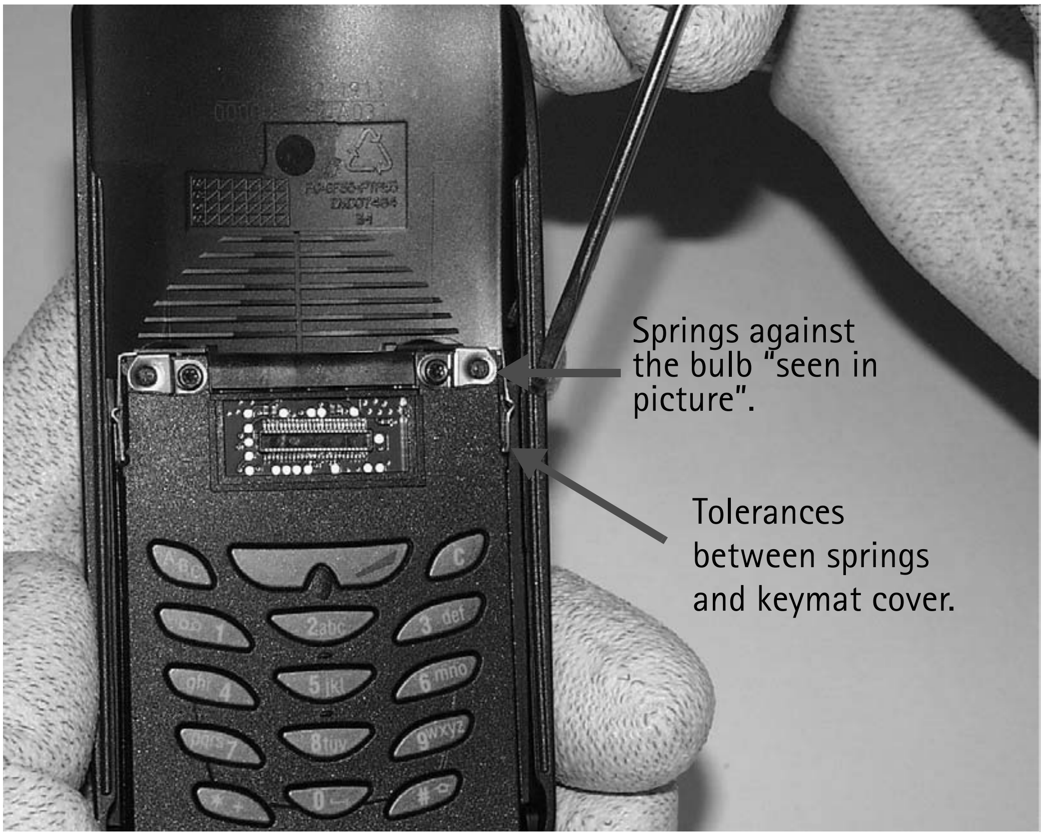
## DC-jack released from grip sequencies



## Grip module positioning springs

1 Positioning spring must be as showed in the picture.

2 End of the springs shall be toward keymat cover approx. + - 0,5mm.

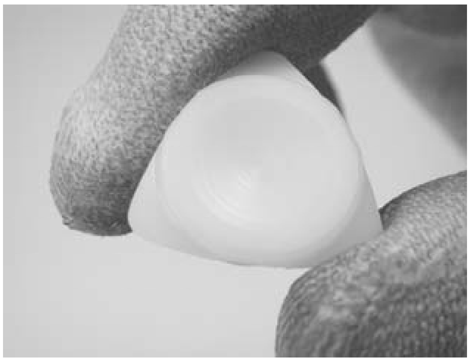


## Things to remember when assembling

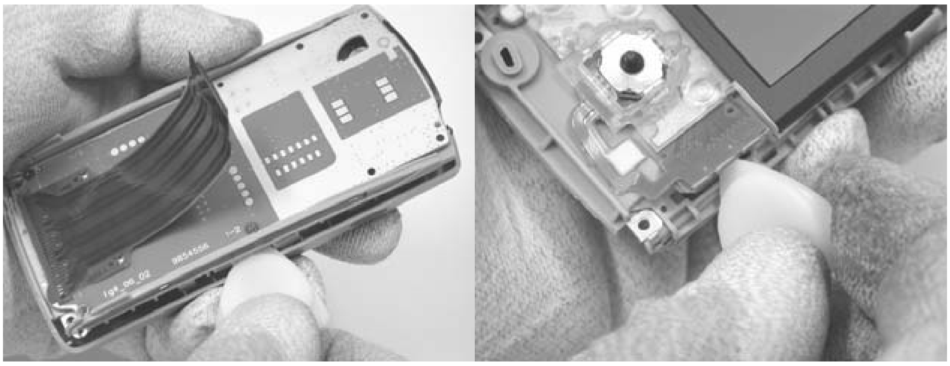
- Assembling instructions are dismantling instructions backwards.
- You do not need any extra force.
- Screwdriving order is as screws are numbered.
- Tightening torque for all screws is 22Ncm, use torque wrench.
- Installing parts from pushing springs is forbidden.
- Do not touch springs vhen dismantling or assembling.
- All spring contacts and PWB pads are sensitive to dirt and grease for instance from hands.
- Be careful not to touch spring contacts or PWB pads with bare hands. Always use gloves.
- New protective tape needed for grip flex.

## Plastic SRT-6 opening tool (for all disassembly sequences)

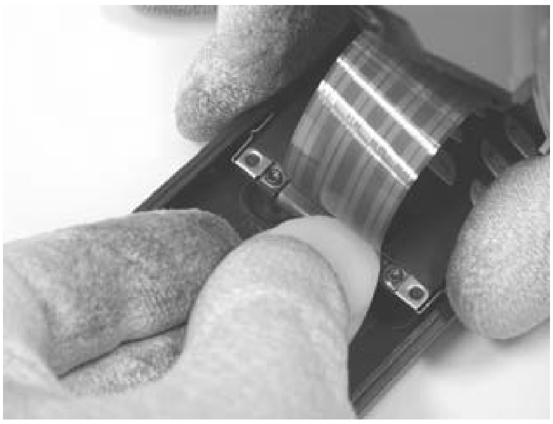
**SRT-6 opening tool:**



**A-cover and UI-module**



**Gripflex**



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# Troubleshooting Instructions

 

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## Table of Contents

# Baseband Troubleshooting

## Introduction

This document is intended to be a guide for localising and repairing electrical faults in the NHL-2NA device. First there is a brief guide for fault localising. Then fault repairing is divided into troubleshooting paths.

Before any service operation you must be familiar with the NHL-2NA product and module level architecture. You also have to be familiar with the NHL-2NA specified service tools such as the Phoenix service software, flashing tools and software.

## General guidelines for NHL-2NA system troubleshooting

### Tools needed for troubleshooting

- Service tools (as listed at service tools chapter in service manual)
- Laboratory power supply with current indicator
- Oscilloscope
- Digital multimeter

### General guidelines

General notes about the NHL-2NA product:

- Large colour display
- Keyboard on grip part, rocker, two softkeys and application key under display + side keys (power key and IHF enabling key)
- Flex cable carries signals between LG4 and LS4 boards. Battery and charger plug is in grip part, so if the flex is damaged phone cannot be powered on.
- UI-module (display, backlights etc.) is also connected to LG4 module with flex cable.
- If the component reference is under 100, component is located at the LS4 board. And if the component reference is over 100, component is located at the LG4 board.

When you get a faulty NHL-2NA device and you start to troubleshoot it, first check the following items:

- If the device cannot be turned on by any means, see “dead device” troubleshooting
- Current consumption (missing consumption) gives an idea wether the device is able to start up.
- Dropping supply voltage or very large current consumption indicates a short circuit
- Check wether the connection with Phoenix works and what can be discovered with Phoenix (ADC-readings, baseband selftest, bb-calibrations etc.)
- Check baseband selftests with Phoenix if “CONTACT THE RETAILER.” is shown on the display.
- Check visually display and rocker faults
- Force phone to LOCAL mode and make keyboard test by phoenix

- Check that board-to-board connector, hotbar and adapter connections are OK, and connectors make good contacts.
- If liquid damage, stop repairing!

If some module (eg. Camera, display, grip) is not working:

- Try working module

If this not helping

- Check supply voltages for failed module
- Check clock(s) for failed module

=> Go to relevant chapter of this document

**Flash phone before disassembling it if fault is not obvious and Phoenix connection is OK.**

**Dissasemble phone:**

Try to locate failed module, is it LG4, LS4, UI or camera module.

- Check failed module visually:

  Mechanical damages?

  Solder joints OK?

Continue with specific troubleshooting procedure for the module:

- If there is an obvious fault, repair it before reflashing the device
- Flash first if a fault is not obvious

If flashing is not working go to flashing troubleshooting

Due to CSP packages short circuits or broken solder joints are not easily seen. If the examined signal seems to be continuously in low or high level, then measure for possible short circuit to ground (signal low) or to supply voltage (signal high) Note that if a problem is not found from any visible contact/component it can be under CSPs where the signal is connected.

Care must be taken when assembling and disassembling the tranceiver. Failure to do this may result in unnecessary damage to device.

NOTE! if some ASIC is changed see chapter Bluetooth troubleshooting

## Nominal current consumption

NOTE: Service tools need some amount of current to work. (FLA-21: 1-2mA and MJF-9Q: 2-6mA

The following current consumption values are measured from a complete NHL-2NA.

Vbatt = 3.8 – 4.2V

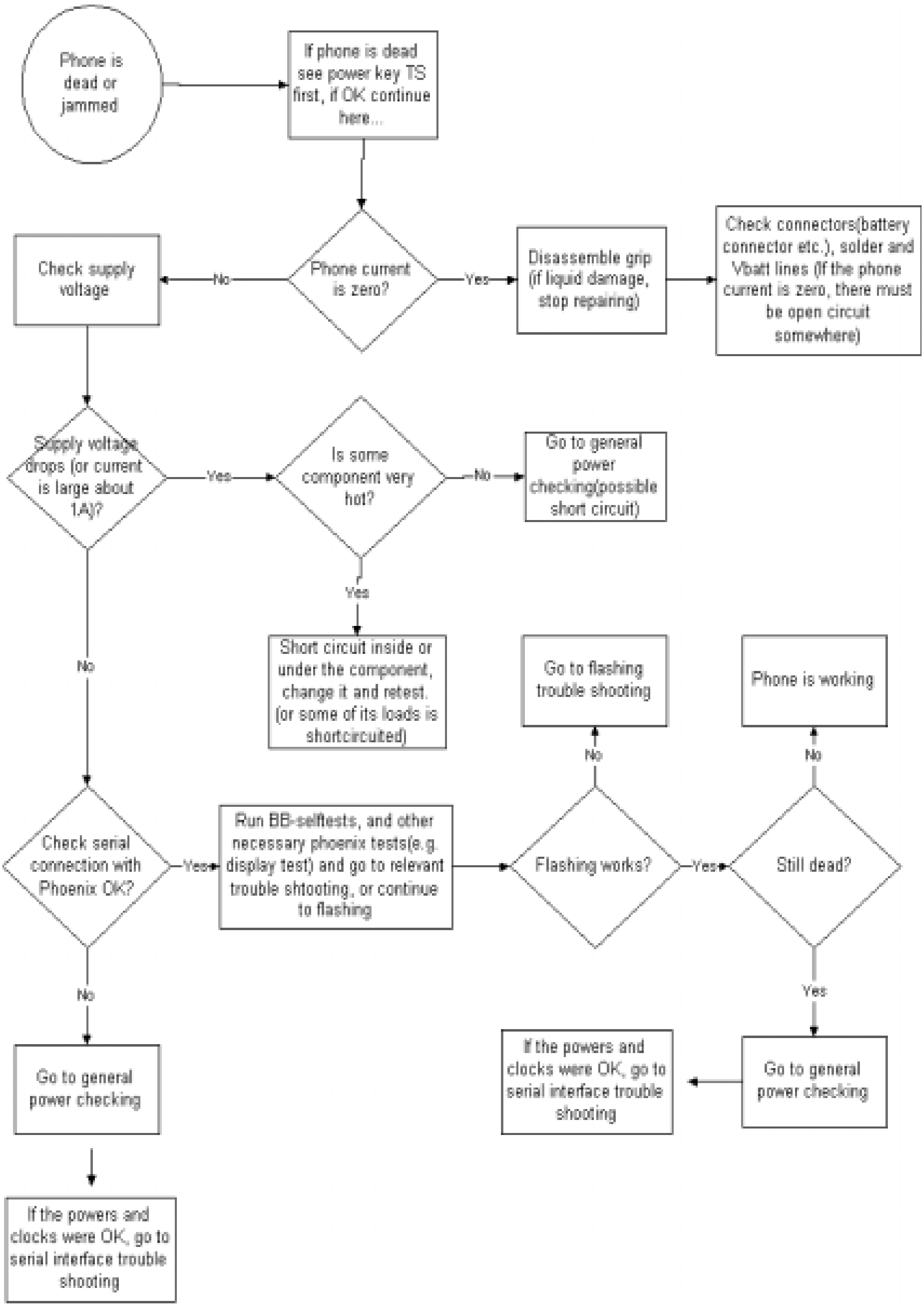
Measured nominal currents are drawn from the main battery.

Measurements have been made with a current probe connected to an oscilloscope.

| Operating mode | Current consumption |
|---|---|
| Idle (BT off) | 4-8 mA |
| 2w audio call (backlights off) channel37 | 300-340mA |
| Viewfinder + nominal backlights | 232mA |

## Troubleshooting paths

### Dead or jammed device



### Partially damaged device

If the device is working, but some functionality is missing try to localize where the problem is and see relevant part of this manual. If, for example, audio is not working see chapter Audio Troubleshooting, if charging is not working see chapter Charging Troubleshooting, etc.

### Most common symptoms reported by customer

In this section is described most common symptoms reported by customers when the device is brought to service. Some tips where the trouble can be found are also given. When troubleshooting use these tips and follow the given troubleshooting path.

**Most common symtoms for audio problems can be**:

“Earpice sound is missing”
”Handsfree sound is missing”
”Headset is not recognized”
”Microphone is not working”
”Volume cannot be adjusted”
” Ringing tones do not work”
”Audio volume too low”

If symptom is something like above see audio troubleshooting.

**Most common symptoms for Irda and bluetooth problems can be**:

“Irda does not work or it does not make a connection”
”Bluetooth does not work or connection cannot be established”

If symptoms are something like those, start to follow Irda or bluetooth troubleshooting guidelines gave relevant chapters.

**Symptoms related to energy management**:

“Phone does not stay on”
”Charging is not working”
”Time is lost during battery change or short main battery removal”
”Charging takes too long”
”Operating time is very short”

These symptoms lead to relevant part of energy managemant trouble-shooting

**If the sensor/sensors are out of order description of symptoms can be like below:**

“IHF is not disabled automatically when phone is put near ear”
“IHF cannot be enabled”
“Backlight is always ON or OFF”
“Backlight of display does not go OFF”

In cases above see Chapter Sensors Troubleshooting or Backlight Trouble-shooting

**Problems in UI-module:**

“UI-module keypad is not working”
”Joystick is not working”
”Backlight is dim”
”Baclight not even”
”Backlight is blinking”
”Keypad or display backlight is not working”
”Display related problems”

See UI- module troubleshooting.

**Most common RF related symptoms:**

“Call cannot be made”
”Phone does not find signal”
”Call is often dropped”

See RF troubleshooting

**Problems with camera can cause symptoms as:**

“Bad image quality”
”Picture cannot be taken”

See camera module troubleshooting

**Problems in LS4 can cause symptoms below:**

”Backlight of grip is dim”
”Baclight of grip not even”
”Backlight of grip is blinking”
”Grip keypad is not working”
”Vibra is not working or is noisy etc.”

See grip- module troubleshooting.

**Contact the retailer” on display**

“Contact the retailer.” on display (Self-tests by Phoenix)

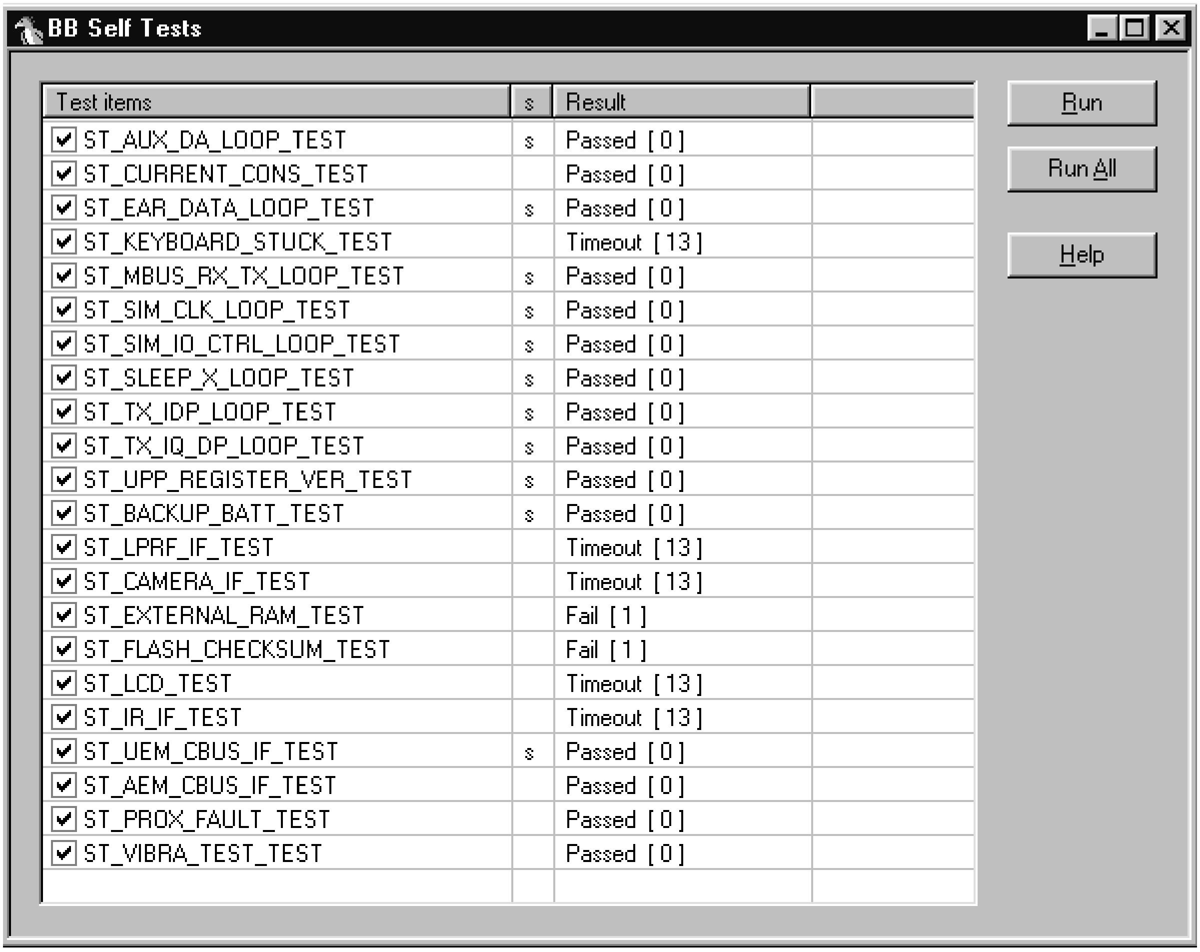
Display information: **“Contact the retailer”**

This fault means that software is able to run and thus the watchdog of UEM can be served.

Selftest functions are executed when the phone is powered on and if one or more selftest functions fail, the message “**Contact the retailer**” is shown on the display.

MCU selftest cases can be split into two categories: The ones that are executed during power up and the ones that are executed only with a PC connected. These tests and the items included are as follows:

**Figure 1: BB selftest-tool**



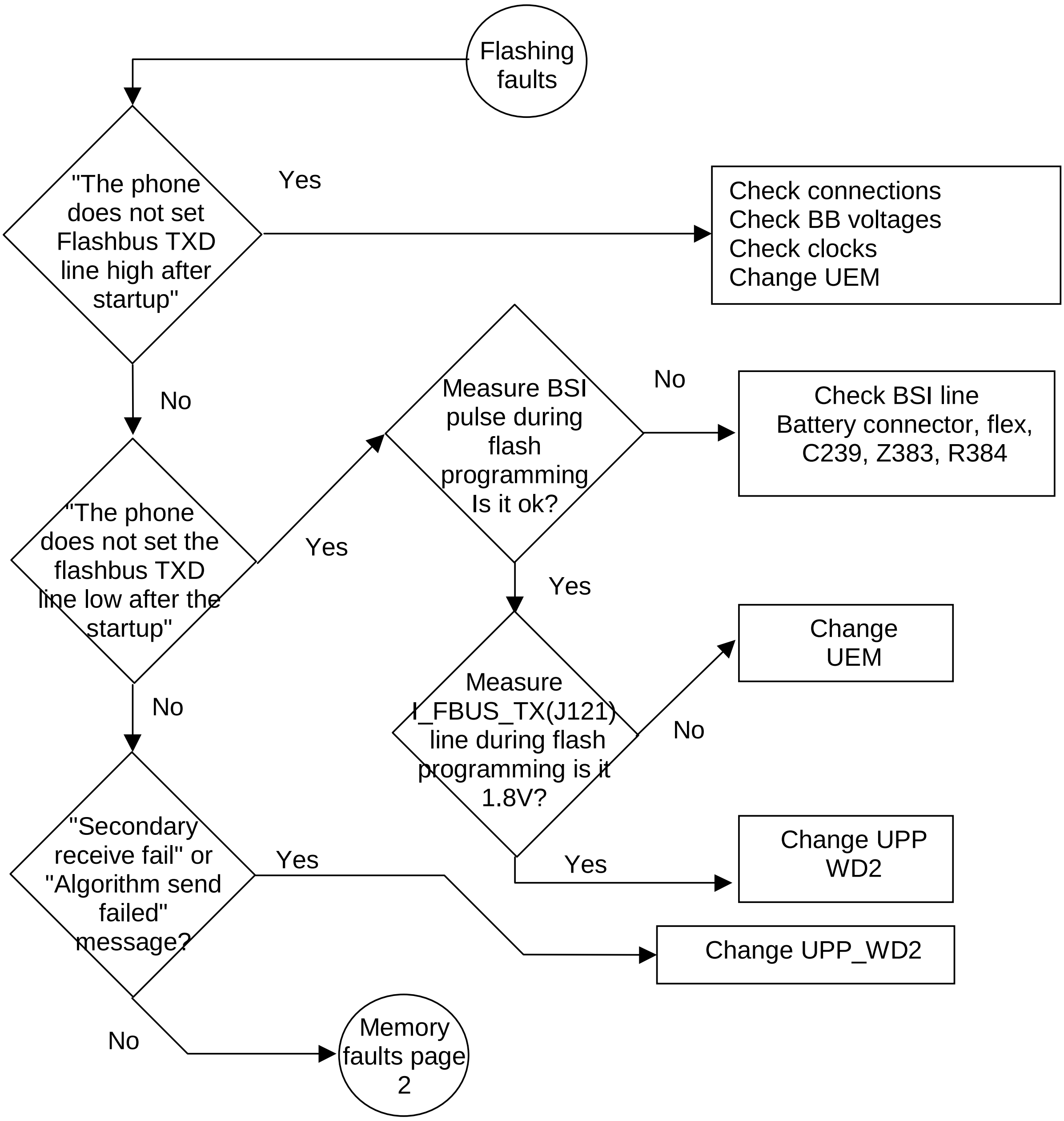

| Test items | s | Result | |
|---|---|---|---|
| ST_AUX_DA_LOOP_TEST | s | Passed [ 0 ] | |
| ST_CURRENT_CONS_TEST | | Passed [ 0 ] | |
| ST_EAR_DATA_LOOP_TEST | s | Passed [ 0 ] | |
| ST_KEYBOARD_STUCK_TEST | | Timeout [ 13 ] | |
| ST_MBUS_RX_TX_LOOP_TEST | s | Passed [ 0 ] | |
| ST_SIM_CLK_LOOP_TEST | s | Passed [ 0 ] | |
| ST_SIM_IO_CTRL_LOOP_TEST | s | Passed [ 0 ] | |
| ST_SLEEP_X_LOOP_TEST | s | Passed [ 0 ] | |
| ST_TX_IDP_LOOP_TEST | s | Passed [ 0 ] | |
| ST_TX_IQ_DP_LOOP_TEST | s | Passed [ 0 ] | |
| ST_UPP_REGISTER_VER_TEST | s | Passed [ 0 ] | |
| ST_BACKUP_BATT_TEST | s | Passed [ 0 ] | |
| ST_LPRF_IF_TEST | | Timeout [ 13 ] | |
| ST_CAMERA_IF_TEST | | Timeout [ 13 ] | |
| ST_EXTERNAL_RAM_TEST | | Fail [ 1 ] | |
| ST_FLASH_CHECKSUM_TEST | | Fail [ 1 ] | |
| ST_LCD_TEST | | Timeout [ 13 ] | |
| ST_IR_IF_TEST | | Timeout [ 13 ] | |
| ST_UEM_CBUS_IF_TEST | s | Passed [ 0 ] | |
| ST_AEM_CBUS_IF_TEST | | Passed [ 0 ] | |
| ST_PROX_FAULT_TEST | | Passed [ 0 ] | |
| ST_VIBRA_TEST_TEST | | Passed [ 0 ] | |

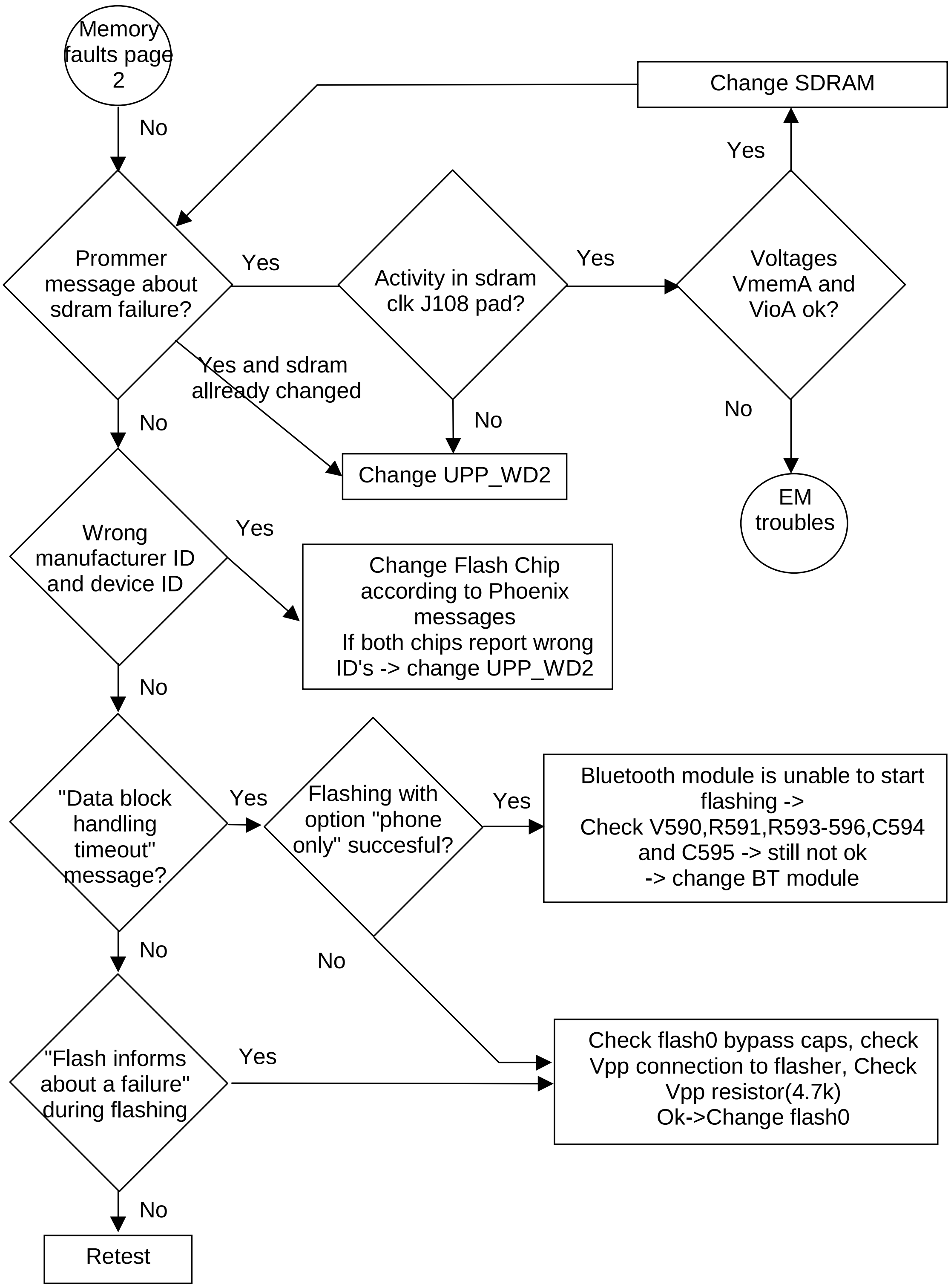
If a selftest fails, see relevant chapter in this troubleshooting manual.

# LG4 Baseband HW subarea troubleshooting

## Flashing troubleshooting

NHL-2NA has three memory components installed on the main pwb. The best indication of which one is causing problems can be obtained by flashing the device. It has to be kept in mind that all three flashes are interfaced with UPP WD2 asic that might itself have some problems. The necessary steps are described below. Phoenix error messages during flashing greatly help on defining what is wrong. To be able to flash the device, most device BB area components must function properly.




Memory faults page 2
No
Change SDRAM
Yes
Prommer message about sdram failure?
Yes
Activity in sdram clk J108 pad?
Yes
Voltages VmemA and VioA ok?
Yes and sdram allready changed
No
No
No
Change UPP_WD2
EM troubles
Wrong manufacturer ID and device ID
Yes
Change Flash Chip according to Phoenix messages
If both chips report wrong ID's -> change UPP_WD2
No
"Data block handling timeout" message?
Yes
Flashing with option "phone only" succesful?
Yes
Bluetooth module is unable to start flashing ->
Check V590,R591,R593-596,C594 and C595 -> still not ok
-> change BT module
No
No
"Flash informs about a failure" during flashing
Yes
Check flash0 bypass caps, check Vpp connection to flasher, Check Vpp resistor(4.7k)
Ok->Change flash0
No
Retest

## Energy management troubleshooting

### Device does not stay on

If the device is switched off without any visible reason, there may be problems in the following areas:

- UEM watchdog problem (WD is not updated by SW)
- BSI line problem (BSI line is floating => contact failure)
- Battery line problem
- Soldering problem

The most likely reason is UEM WD (watchdog), which turns the device off after about 32 seconds if SW is jammed.

This may be caused by a SW problem, UPP_WD2 problem (Not server by SW), UEM, AEM or memory malfunctions.

The following tests are recommended:

- General power checking
- Clocks
- Memory testing
- Serial Interface

If there is something wrong in BSI line, the device seems to be dead after the power key is pressed. However the regulators of the device are on a few seconds before the power-down.

This mode can easily be detected from the current consumption of the device. After a few seconds the current consumption drops almost to 0 mA.

In this case check components listed below or soldering:

Battery connector X002
Grip connector X001 (especially pin number 27)
Hotbar soldering X380 (especially pin number 5)
EMI-filter Z383 (especially pins number A4 and E4)
UEM D190 (pin number C2)

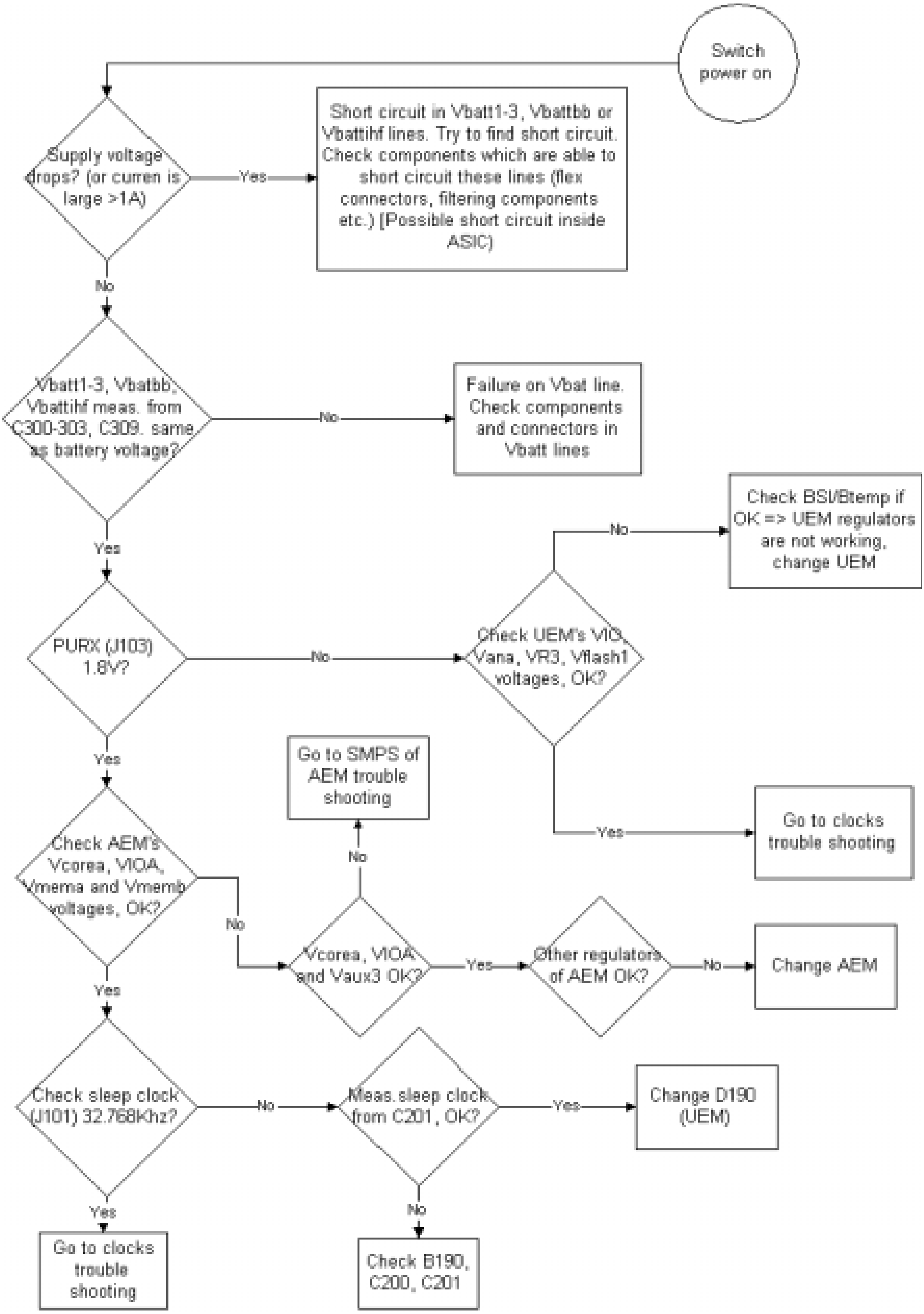
If phone boots to TEST or LOCAL mode with normal battery, BSI or Btemp or both lines are short circuited to ground. Check varistors, EMI-filter and filtering capacitors, which are located to BSI and Btemp lines.

### General power checking

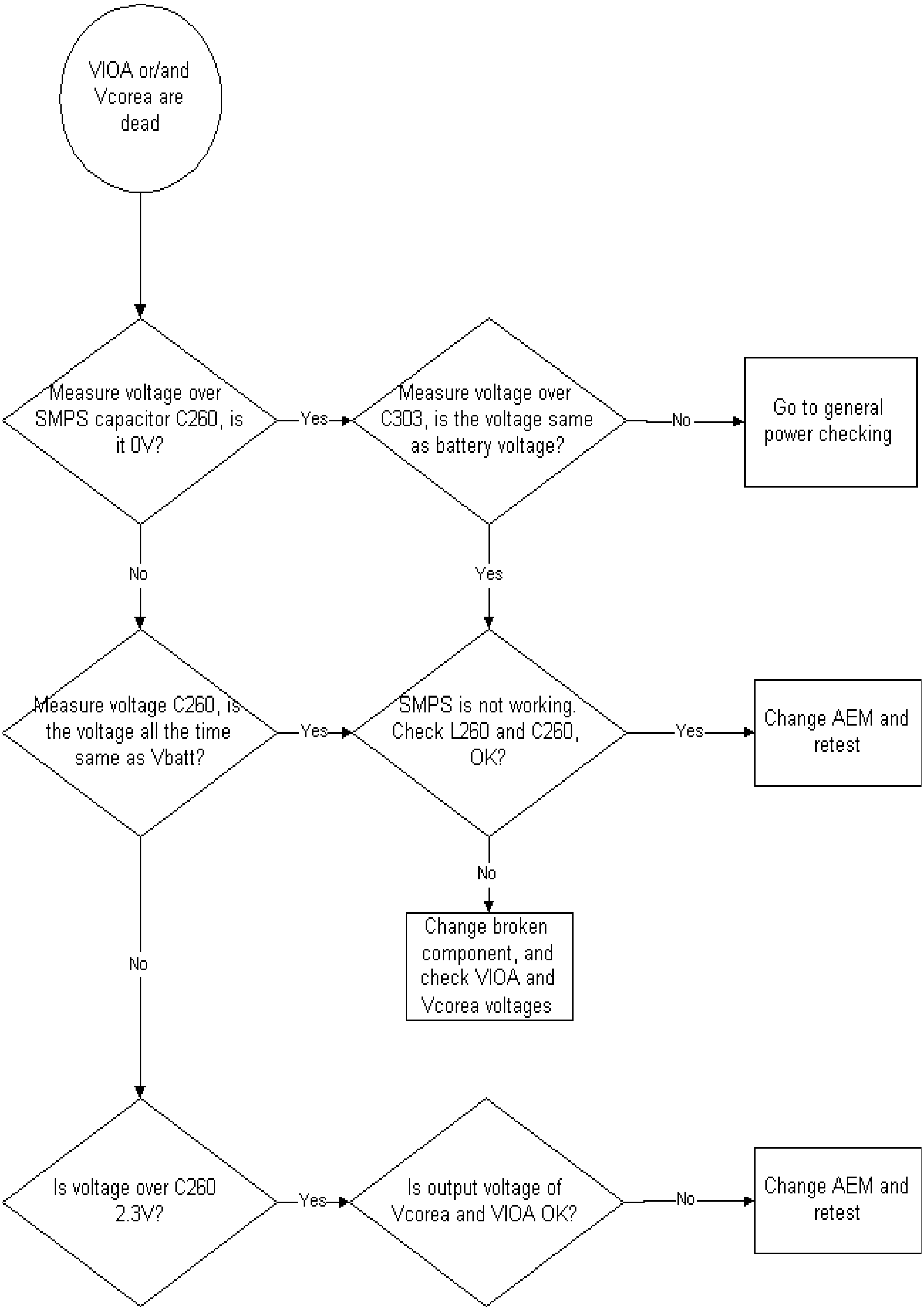
Use service tool FLA-21. Battery voltage should be atleast 3.6V. After phone disassembly, use module jig MJS-9Q.

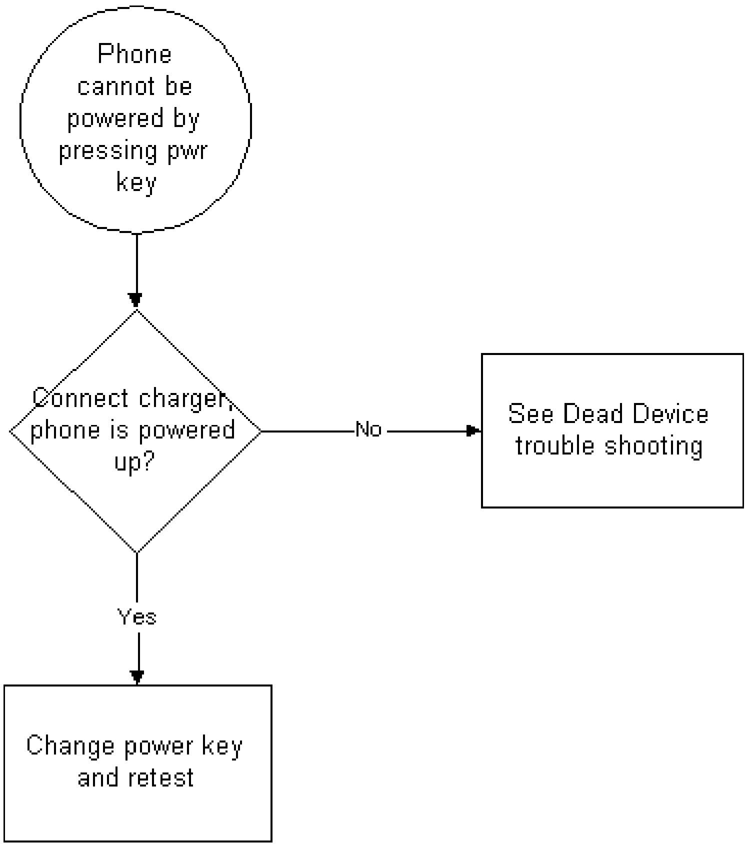
.


Switch power on
Supply voltage drops? (or curren is large >1A)
Yes
Short circuit in Vbatt1-3, Vbattbb or Vbattihf lines. Try to find short circuit. Check components which are able to short circuit these lines (flex connectors, filtering components etc.) [Possible short circuit inside ASIC)
No
Vbatt1-3, Vbatbb, Vbattihf meas. from C300-303, C309. same as battery voltage?
No
Failure on Vbat line. Check components and connectors in Vbatt lines
Yes
PURX (J103) 1.8V?
No
Check UEM's VIO, Vana, VR3, Vflash1 voltages, OK?
No
Check BSI/Btemp if OK => UEM regulators are not working, change UEM
Yes
Go to clocks trouble shooting
Yes
Check AEM's Vcorea, VIOA, Vmema and Vmemb voltages, OK?
No
Vcorea, VIOA and Vaux3 OK?
No
Go to SMPS of AEM trouble shooting
Yes
Other regulators of AEM OK?
No
Change AEM
Yes
Check sleep clock (J101) 32.768Khz?
No
Meas.sleep clock from C201, OK?
Yes
Change D190 (UEM)
No
Check B190, C200, C201
Yes
Go to clocks trouble shooting

## SMPS of AEM troubleshooting



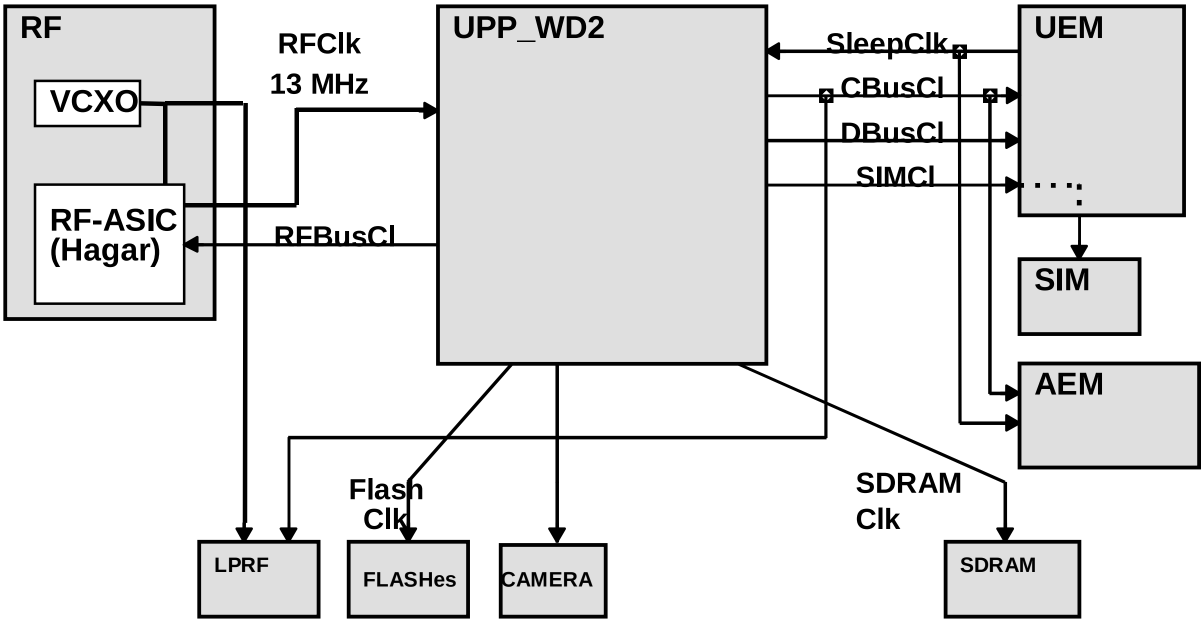
**Power key troubleshooting**



### Clocks troubleshooting

The main clock signal for the baseband is generated from the voltage and temperature controlled crystal oscillator VCTCXO (G591). This 26 MHz triangle wave clock signal is supplied to OSC_IN pin of HAGAR. Inside HAGAR the clock frequency is divided to 13 MHz and then fed to RFCLK pin of UPP_WD2 and Bluetooth.

In SLEEP mode the VCTCXO is off. UEM generates low frequency clock signal (32.768 kHz) that is fed to UPP_WD2, Bluetooth and AEM.



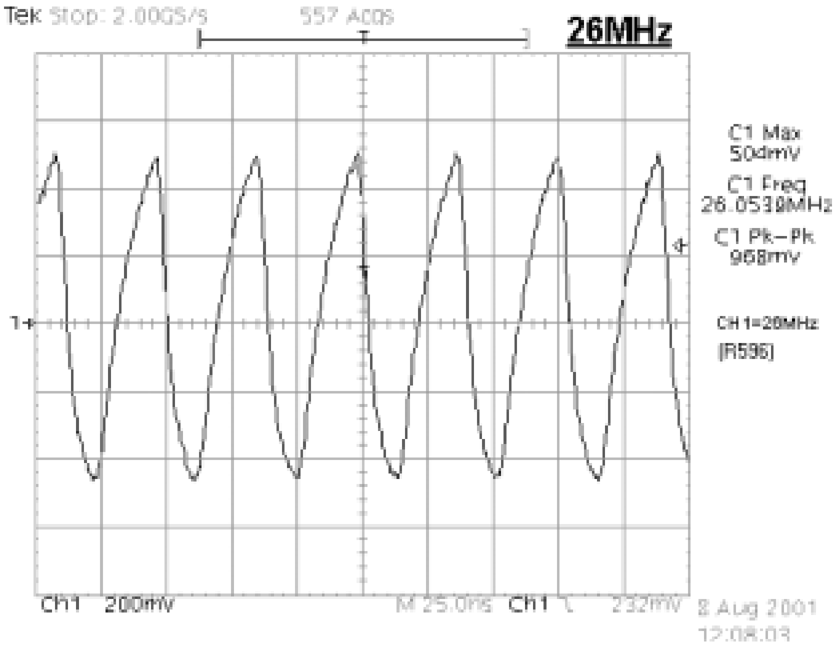

When the flashing of the device does not succeed, but powering is OK, follow these instructions.

Note: The absence of clocks may indicate that the device (put phone to LOCAL mode when the sleep is not allowed or press buttons so that phone is not in sleep mode) is in sleep mode. Make sure that the device is not in sleep during RF clock measuring.

*IMPORTANT: Clock signals have to be measured with 1MΩ (or greater) probes!*

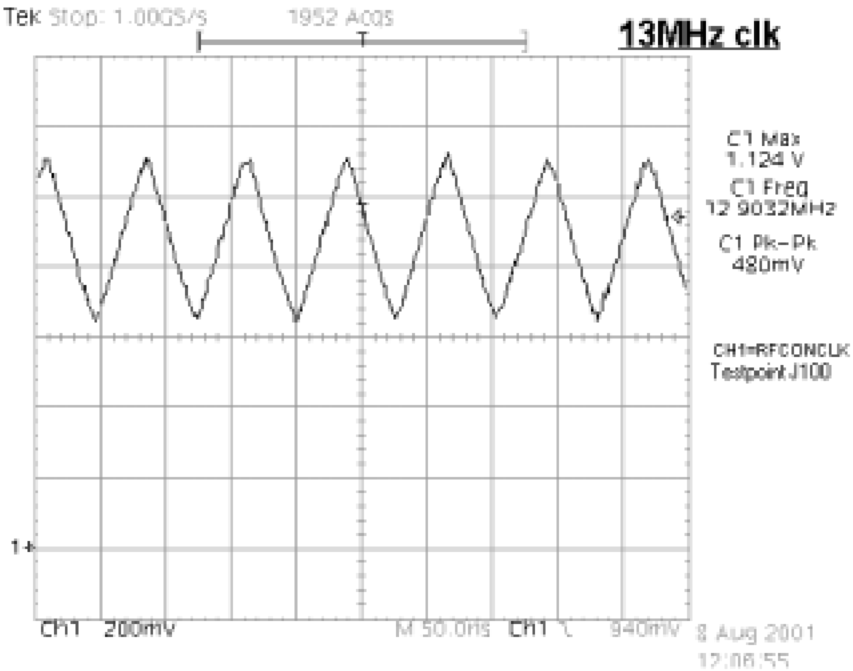
1 Measure signal from R596. This should be 26Mhz clock signal. See figure below. If the clock not exist, check voltage from C662, it should be 2.78V (UEM regulator VR3). If voltage is OK, check G591 and other componets around it.

**Figure 2: 26 Mhz clock**

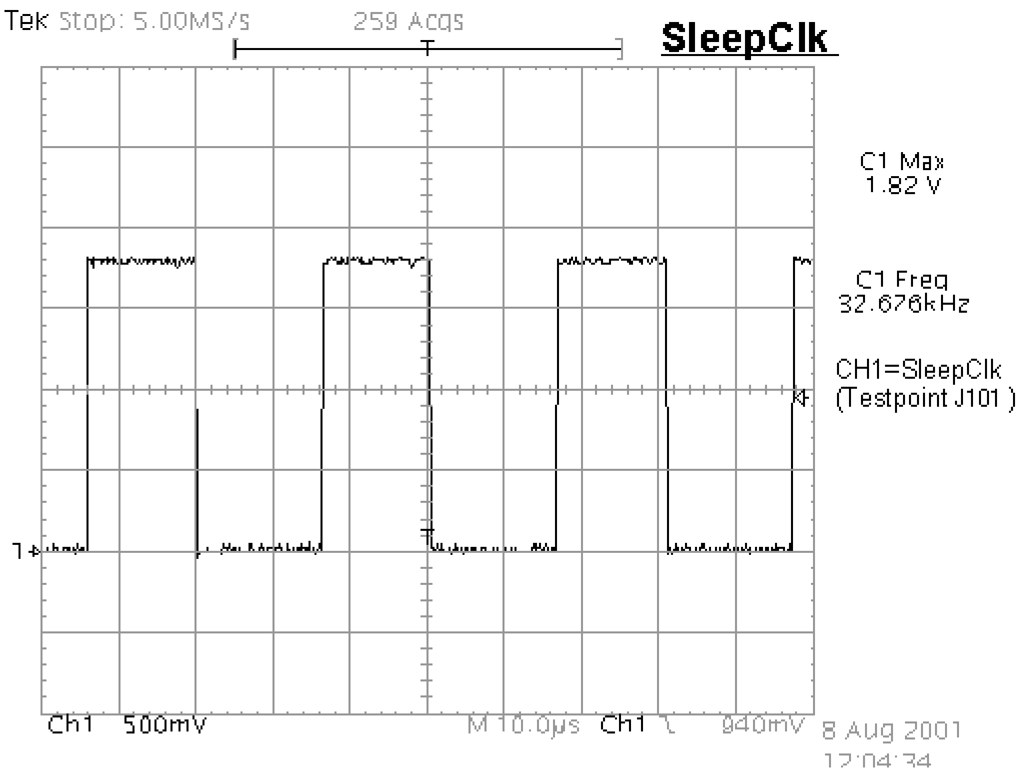



2 Check 13Mhz Rfclk from testpoint J100. See figure below. Offset should be about 900mV. If the offset does not exist something is broken inside UPP_WD2 or DC-filtering capacitor in series on trace.

**Figure 3: 13 MHz clock**



3 Check is the crystal oscillator (B190) oscillating at 32.768kHz frequency. If not change B190. If OK measure sleepclk from testpoint J101. Frequency should be the same 32.678kHz (see figure below.) If not change UEM.

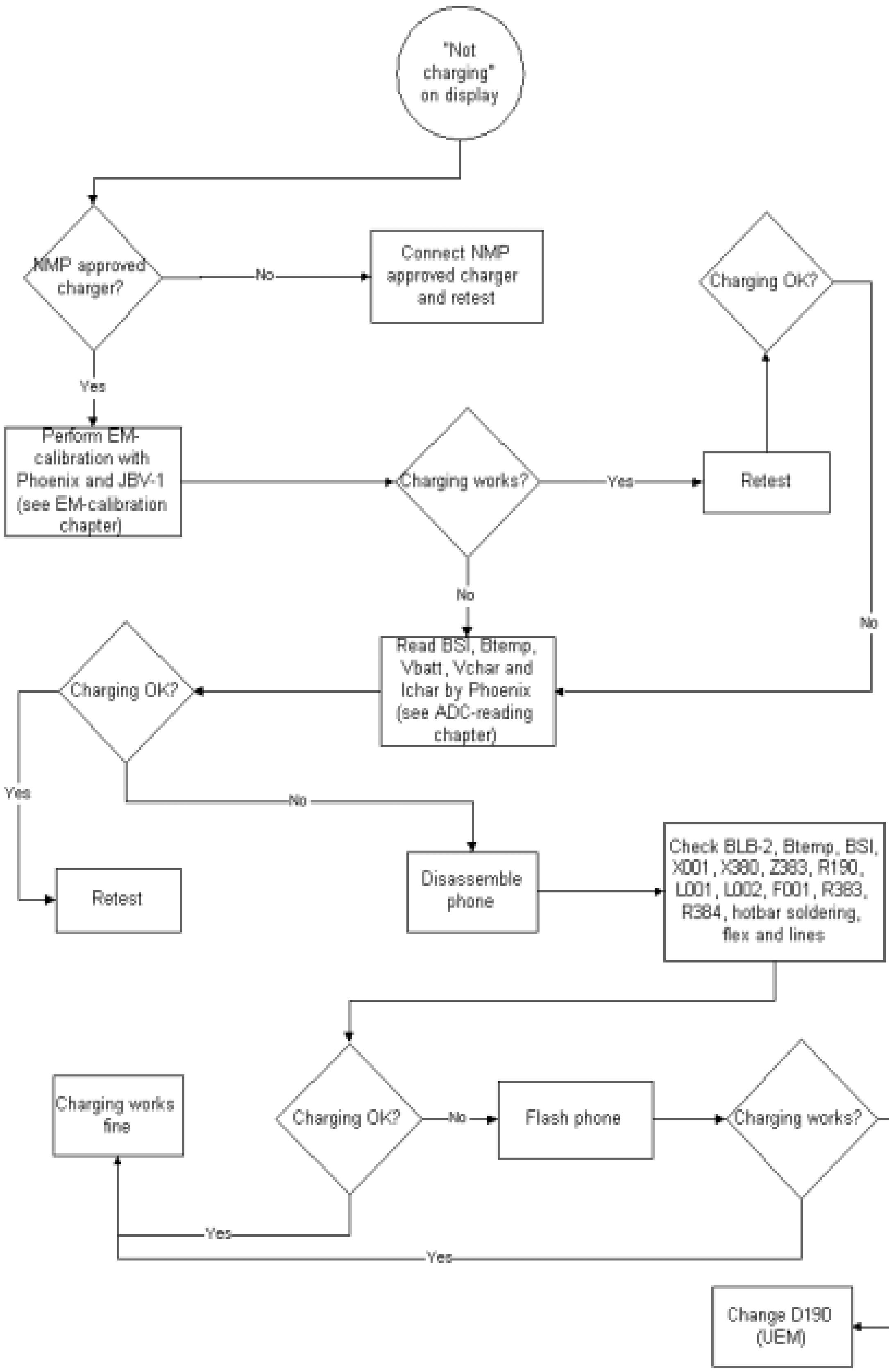


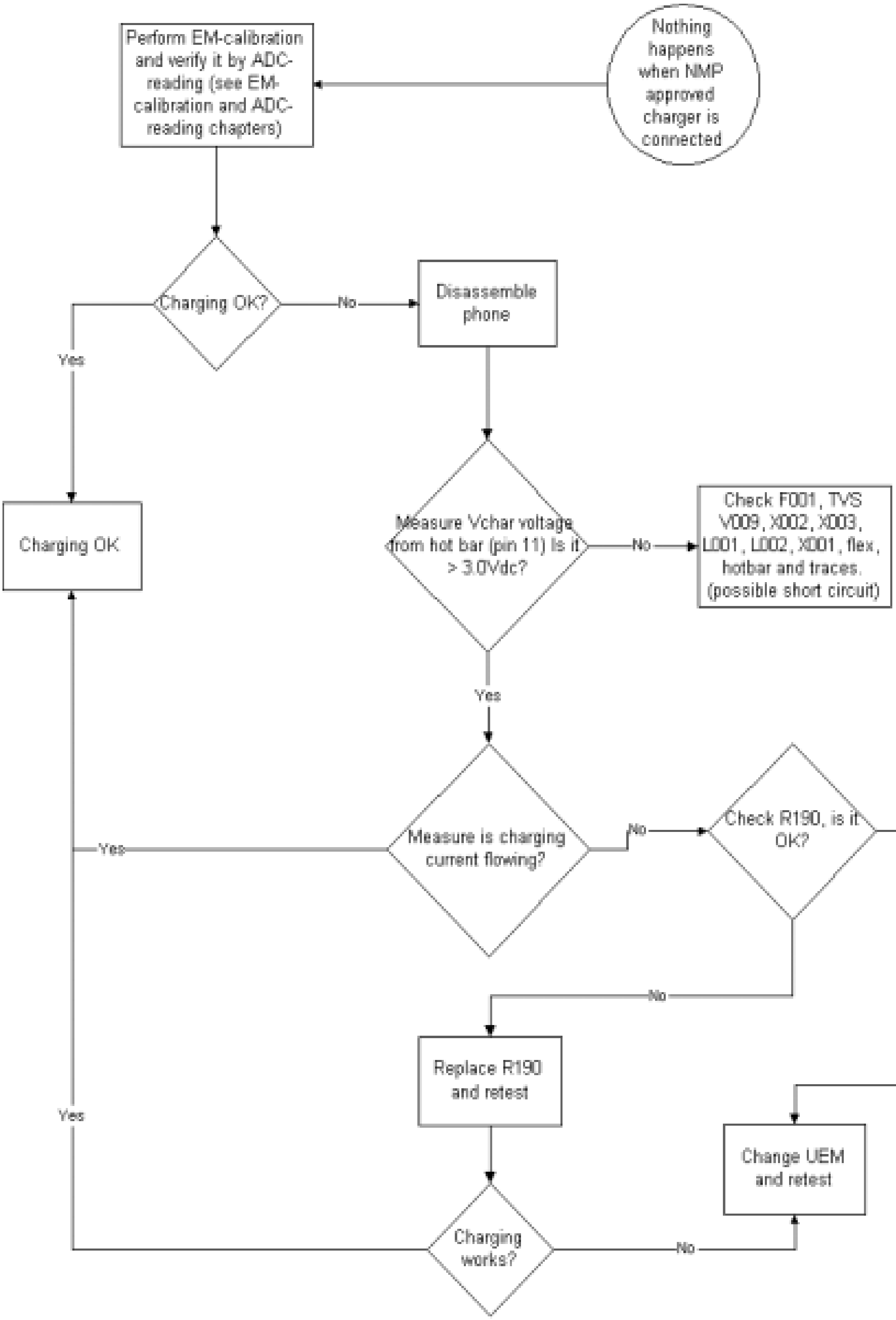
### Charging checking

Use the BLB-2 battery and JBV-1 calibration set to test charging. (NOTE: power supply cannot be charged if it not has a current sinking capability.) When you are charging totally empty battery, remember that start-up charging might take a little bit longer time than normal. During this time display is blank.

If charger is not NMP approved type and its current and voltage is not within NMP charger window then software does not start charging and there is “NOT CHARGING” on the display. Voltage should be between 5.5V - 9.3V and current between 200mA – 850mA

Remove and reconnect battery and charger few times before you start to measure device. This check ensures that the fault really exists.


"Not charging" on display
NMP approved charger?
No
Connect NMP approved charger and retest
Yes
Perform EM-calibration with Phoenix and JBV-1 (see EM-calibration chapter)
Charging works?
Yes
Retest
Charging OK?
No
No
Read BSI, Btemp, Vbatt, Vchar and Ichar by Phoenix (see ADC-reading chapter)
Charging OK?
Yes
Retest
No
Disassemble phone
Check BLB-2, Btemp, BSI, X001, X380, Z383, R190, L001, L002, F001, R383, R384, hotbar soldering, flex and lines
Charging works fine
Charging OK?
No
Flash phone
Charging works?
Yes
Yes
No
Change D190 (UEM)


Nothing happens when NMP approved charger is connected
Perform EM-calibration and verify it by ADC-reading (see EM-calibration and ADC-reading chapters)
Charging OK?
No
Disassemble phone
Yes
Charging OK
Measure Vchar voltage from hot bar (pin 11) Is it > 3.0Vdc?
No
Check F001, TVS V009, X002, X003, L001, L002, X001, flex, hotbar and traces. (possible short circuit)
Yes
Measure is charging current flowing?
Yes
No
Check R190, is it OK?
No
Yes
Replace R190 and retest
Change UEM and retest
Yes
Charging works?
No

## Energy management calibration

During energy management calibration A/D-converter, BSI, Btemp, Battery voltage, Charger voltage and Charger current are calibrated**. For detailed information and instructions see EM-calibration instructions in service manual**.

Troubleshooting tips:
ADC-offset over limits:
Inspect BSI line, connectors (hotbar and board to board connector) and components in it (Varistor R008, EMI-filter Z383, Pull-up resistor R384). If these are OK, change UEM.

BSI Gain over limits:
Inspect BSI line, connectors (hotbar and board to board connector) and components in it (Varistor R008, Capacitor C002, EMI-filter Z383, Pull-up resistor R384). If these are OK, change UEM.

Btemp Gain over limits:
Inspect Btemp line, connectors (hotbar and board to board connector) and components in it (Varistor R006, Capacitor C010, EMI-filter Z383, Pull-up resistor R383). If these are OK, change UEM.

Vbatt offset and Gain:
Inspect Vbatt lines and component in it.

Vchar over limits:
Inspect components which are connected Vchar line: Filtering capacitors C005, C006, C011, TVS V009, L001 and Fuse F001. If those are OK, Change UEM

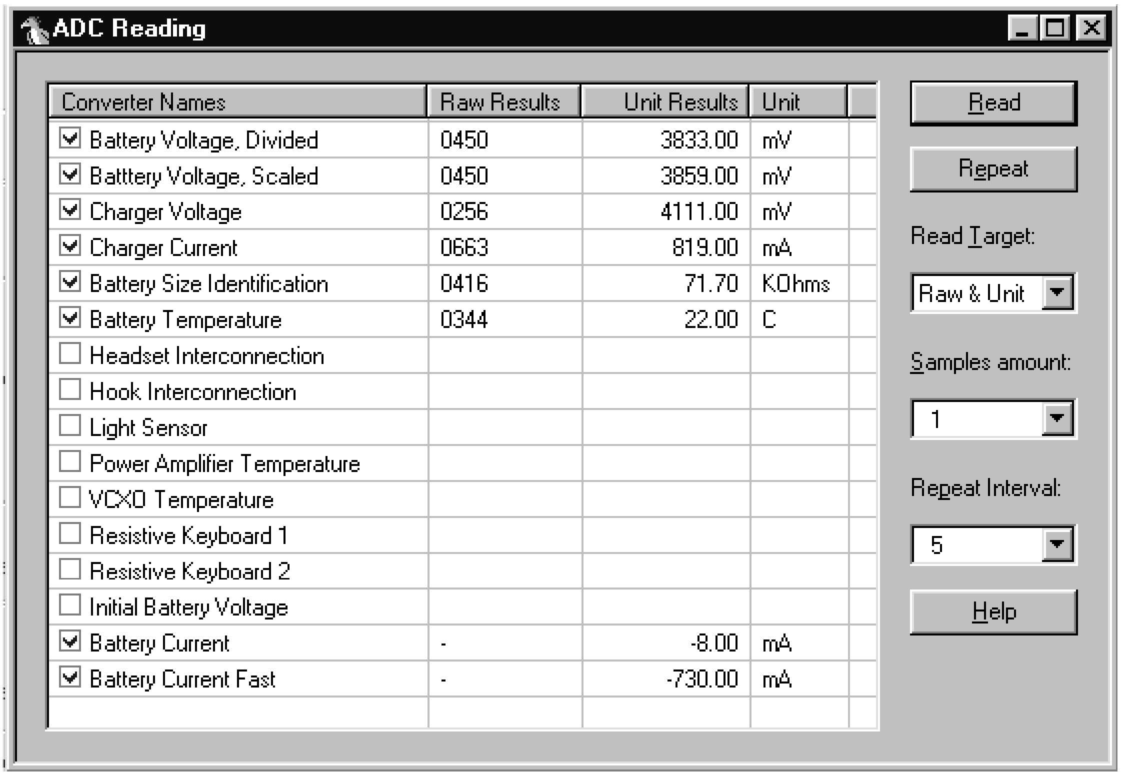
Ichar over limits:
Inspect components which are connected at Vchar line: Filtering capacitors C005, C006, C011, TVS V009, L001 and Fuse F001. If those are OK, First change current sense resistor (R190), if calibration is not still successful change UEM.

Calibration can be checked using ADC-redings. Known voltages, currents and resistances are fed and read by ADC-readings, read values and known values can be compared.

### ADC-reading

Divided and scaled battery voltage, Charger voltage, Charger current, BSI and Btemp values can be read by this tool. Read values few times before you can be sure that results are accurate.

**Figure 4: ADC-readings view**




*Note:: If Vbatt Scaled and Divided unit results are different default calibration values are used. In this case perform EM-calibration to get full performance of phone.*

Maximum tolerances are:

| Reading | Check point | Tolerance |
|---|---|---|
| Vbatt SCAL_ | 4.2V | ± 25mV |
| Vchar | 8.4V | ± 40mV |
| Ichar | 500mA | ± 20mA |
| BSI | 68k(BLB-2) | ± 1.3kohm |
| Btemp | 273K(47k) | ± 5K |

### Backup battery

Symptom of backup battery fault is:
Real Time Clock loses the correct time during short main battery removal.

The same syptom can also be seen when the backup battery is empty. About 5 hours is needed to fully charge the backup battery in the device. NOTE: Backup battery is charged only the same time with main battery charging. Or when the device is LOCAL or TEST mode.

Always check that the backup battery visually for any leakage or any other visual defect.

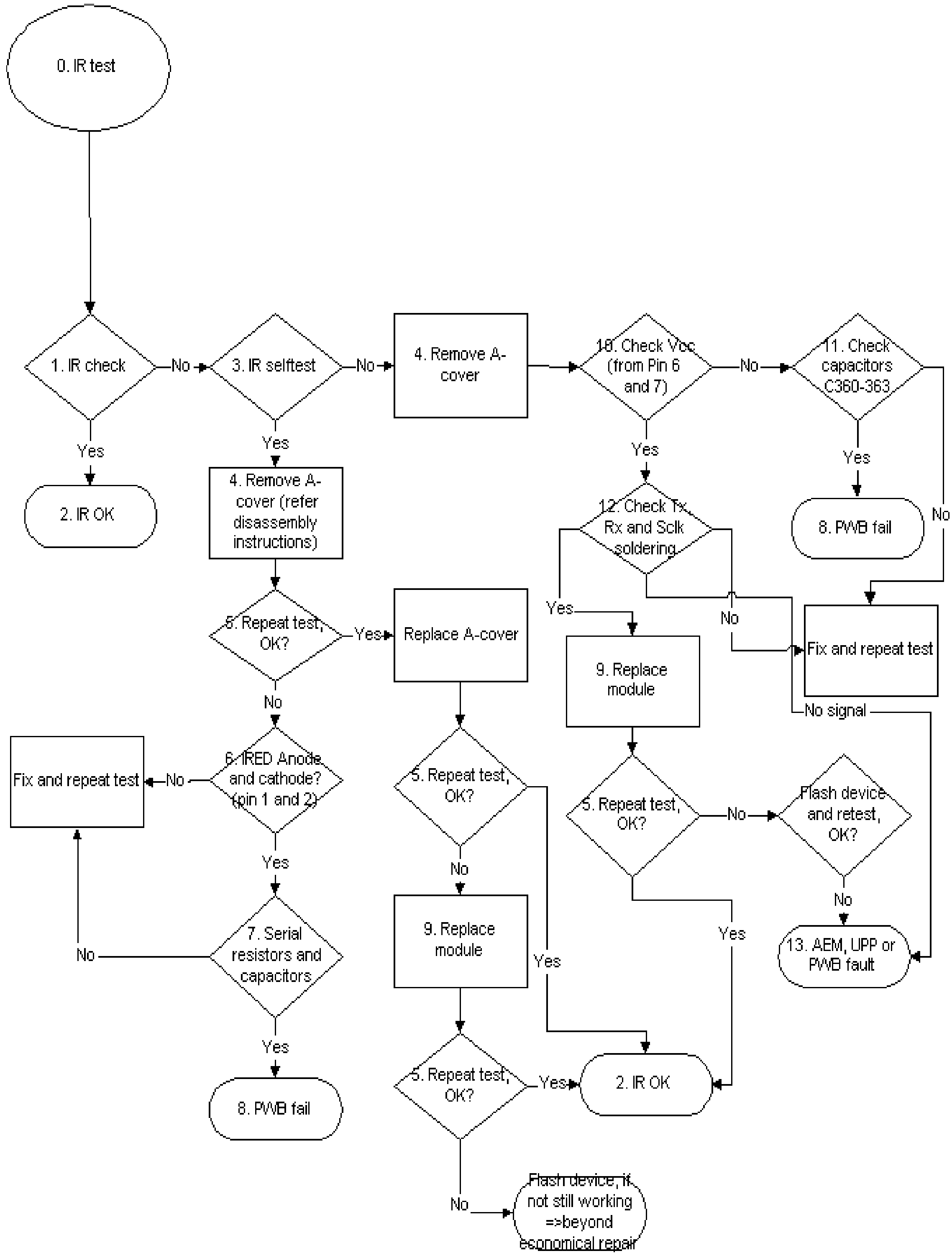
Check that the backup battery is correctly mounted in the device before closing the cover.

1 Check with Phoenix is backup battery OK
2 Measure the voltage of backup battery
- Normal operation when the voltage is > 2.0V
- Fully charged when the voltage is about 3.2V (because of large internal imped ance voltage won't stay above 3.0V a long time after charging is disabled)

3 Enable backup battery charging (start to charge main battery or boot device to LOCAL or TEST mode)
4 Measure voltage of backup battery during charging, It should arise if it is not 3.2V, yet.
5 When the voltage is over 2.0V for sure, check backup battery with Phoenix.
-> If not OK then D190 is faulty.
6 Ensure that the RTC is running.

## IR interface



0. At this point it is supposed that problem is in HW

1. Send something to another phone or laptop

2. Everything is ok

3. Activate phones IrDA selftest

4. Take off phones A-cover

5. Start test again from the beginning, there might be more than one fault...

6. Check pin number 1 with voltage meter, first the pad and then the pin, there is supposed to be battery voltage

7. Make sure resistors R360 – R363 are connected and < 10ohm

8. Propably the fault is in PWB

9. Replace the IR module

10. Check Vcc, pins 6 and 7 in IR module, supposed to be connected to VMEMA, again first the pads and then the pins

11. Looking for shortcircuits in capacitors C360-C363

12. Check lines 3, 4 and 5 in IR module with oscilloscope during IR selftest, there should be series of pulses. Again check first pads and then pins.

13. Beyond economical repair

## Sensors troubleshooting

This part of document is written to help troubleshooting for proximity sensor and ambient light sensor in NHL-2NA. Both of them are calibrated in production, in FINUI tester. AMS has possibility to calibrate proximity sensor at service points, ambient light sensor is repaired in Bochum.

This document is ment to be used only in troubleshooting and does not provide information on basic functionality of the systems. Basic operating principle can be found in chapter “System Module LG4 and Grip Module LS4”, calibration instructions can be found in chapter “Service Software Instructions”.

## Proximity Detector

### General notes

In the production proximity detector problems are best located from calibration results. Before starting troubleshooting with the help of this section, user should familiarize to the calibration instructions.

When the user brings the phone to the service point complaining that handsfree won't turn on, the problem can be either in the handsfree speaker circuitry, or in the proximity detector. This chapter gives instructions how to repair the problem in the proximity detector.

A good indicator that the proximity detector has caused disabling of the loudspeaker is, that the phone has switched the audio back to the earpiece. If the audio is not switched to the earpiece but also loudspeaker is not on, the problem is most likely in the handsfree circuitry.

When the problem is located on the proximity detector, the first thing to do is to check that proximity detector lenses are roughly OK. If any physical damage is found, replace lens module before proceeding to detailed troubleshooting.

If the problem is not this simple, the best way to look for the problem is to use PD calibration.

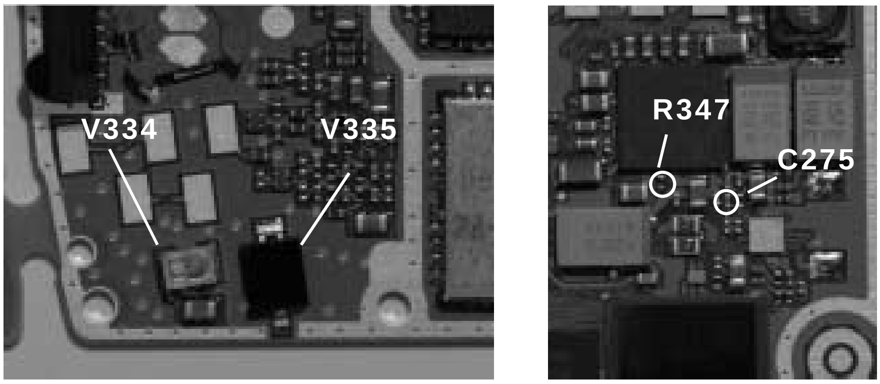
Remember that Proximity Detector has to be calibrated always when optocomponents or optics are replaced! Calibration also has to be done, if AEM ASIC is replaced or if calibration settings are lost from PMM.

### Proximity Detector components

From now on Proximity Detector will be referred to as PD.

Main components of PD are lenses, emitter (IRED CL-200-IR, V334, 4860009), RSENSE 4R3 (R347), receiver (photodiode BPW34FS, V335, 486J830) and a control block, which is located on AEM ASIC (N226). Three external capacitors are part of the control block: 100n (C275) and 220p (C273 and C274).

**Figure 5: Most important receiver and transmitter components**



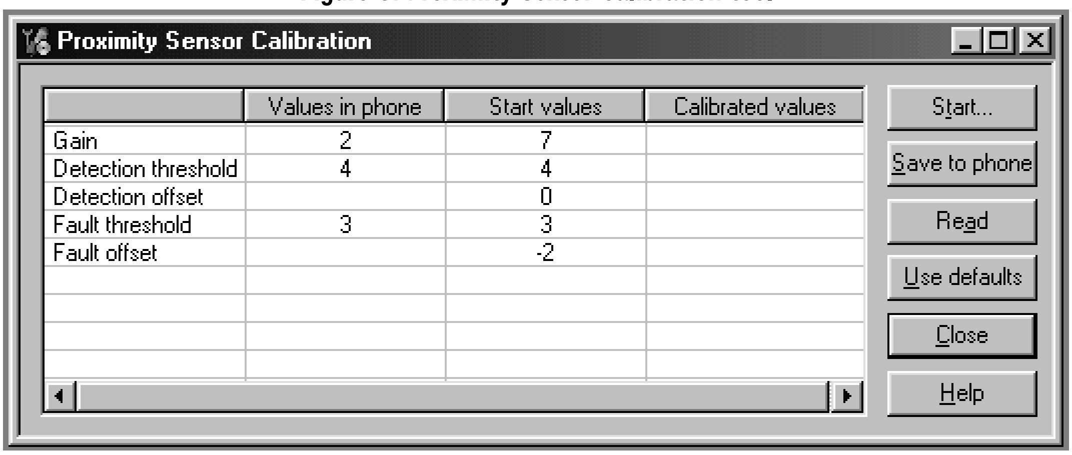

### Handsfree shuts down automaticallly in sunshine

It is normal, if this behaviour occurs only in high ambient light conditions, e.g. direct sunlight, and no repair actions are needed. If this problem occurs also in low ambient light conditions (outdoors when the phone is not facing the sun), check that capacitors C273, C274 and C275 are placed correctly.

### PD calibration

Proximity Sensor Calibration tool is shown in the Figure 4 Proximity Sensor Calibration tool. Parameters that are calibrated and saved to PMM are gain, detection threshold and fault detection threshold. When you start the calibration tool, the values in the PMM are shown in the left column. Second column shows start values used in calibration, they are defined by R&D. Calibration consists of two phases. First gain and detection threshold are calibrated. If this calibration is finished successfully, software starts fault threshold calibration; fault threshold cannot be calibrated alone. Offset value(s) are used to adjust the thresholds to compensate possible wearing of the PD. To help troubleshooting phone SW response is one of the 13 messages that are explained in the next chapter. Successful gain and detect threshold calibration tells that optoelectrical components are OK. Note! Values in this picture might change.

**Figure 6: Proximity Sensor Calibration tool**




| | Values in phone | Start values | Calibrated values |
|---|---|---|---|
| Gain | 2 | 7 | |
| Detection threshold | 4 | 4 | |
| Detection offset | | 0 | |
| Fault threshold | 3 | 3 | |
| Fault offset | | -2 | |

**Troubleshooting with PD Calibration results**

CALIB OK (0x00)

This is the response, when calibration is done successfully. Save calibration results to the phone.

START ILLEGAL PARAMETER (0x01)

Calibration starts with rough check for start values. Detection threshold, gain and fault detection threshold must be between 0 and 7; offset for both of them is from -7 to 7.

Default start parameters never fail to meet these limits. Check that correct limits are used in the calibration SW (PC or Phoenix) and try calibration again.

PXM GAIN INT FAIL (0x02)

This should be impossible. If, however, you manage to get this error, try calibration again.

DET TR FAIL (0x03)

An error has occurred during calibration. Try calibration again. If no result is obtained in three calibrations, replace proximity optics.

Another option is, that detection offset is too big for calibrated detection threshold. This isn’t possible, if start values are correct. Use default start values.

OFFSET FAIL (0x05)

Selected offset could not be used with this calibration result. Check, that you have used correct default offset. Then replace the optics.

DET NOT DONE (0x06)

Fault calibration can be done only directly after detect calibration. If, for example, the phone was restarted between fault –and detect calibration, this error occurs. Repeat whole calibration.

COMBINATION FAIL (0x07) / W OFF FAIL (0x08)

Calibrated detection threshold, fault detection threshold and detection offset form a combination that is not allowed. Use default start values in calibration and check that proximity rubber is OK. If this does not help, replace optics.

FAULT INT FAIL (0x09)

This error occurs, if self-monitoring signal is too small to exceed any fault threshold (when offset is added). This error occurs also if there is a detection during fault threshold calibration.

Is proximity optics and proximity rubber OK (visual check)? If not, replace optics. Check calibration conditions and repeat calibration.

FAULT OVER LIMIT FAIL (0x10)

This error occurs in fault detection threshold calibration, if self-monitoring signal is higher than each fault detection threshold. There are two reasons, that could cause this failure:

Detection calibration is done without the calibration target or the target was too far from the phone.

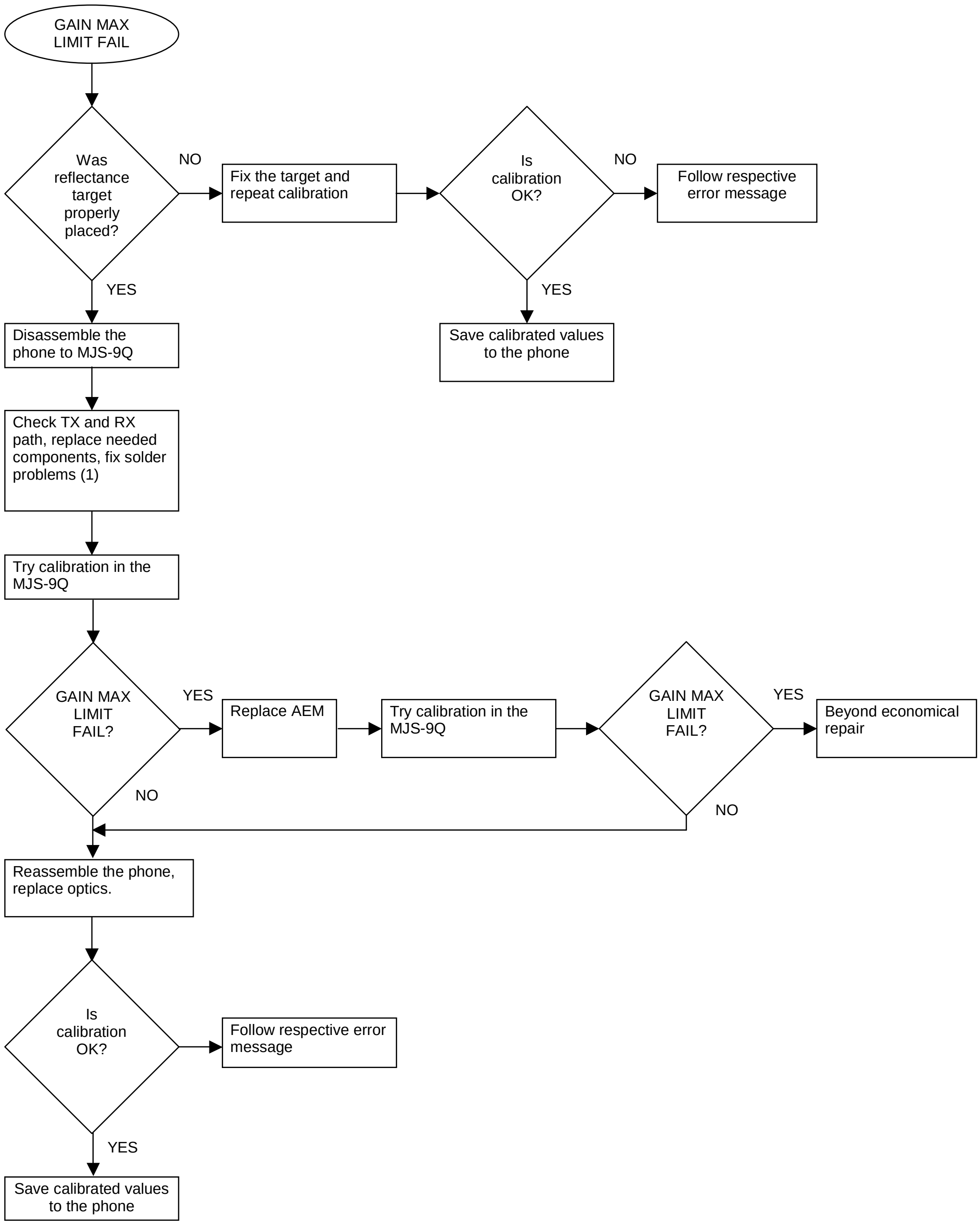
Fault calibration was done with the calibration target.

Check calibration conditions and repeat calibration.

GAIN MAX LIMIT FAIL (0x0B)

Gain value has reached its maximum limit, and there are no detections. This means, that path from tx to rx is broken. Most probable is, that the failure is on the LG4. Figure 5 GAIN MAX LIMIT FAIL troubleshooting presents troubleshooting diagram for this failure.

**Figure 7: GAIN MAX LIMIT FAIL troubleshooting**



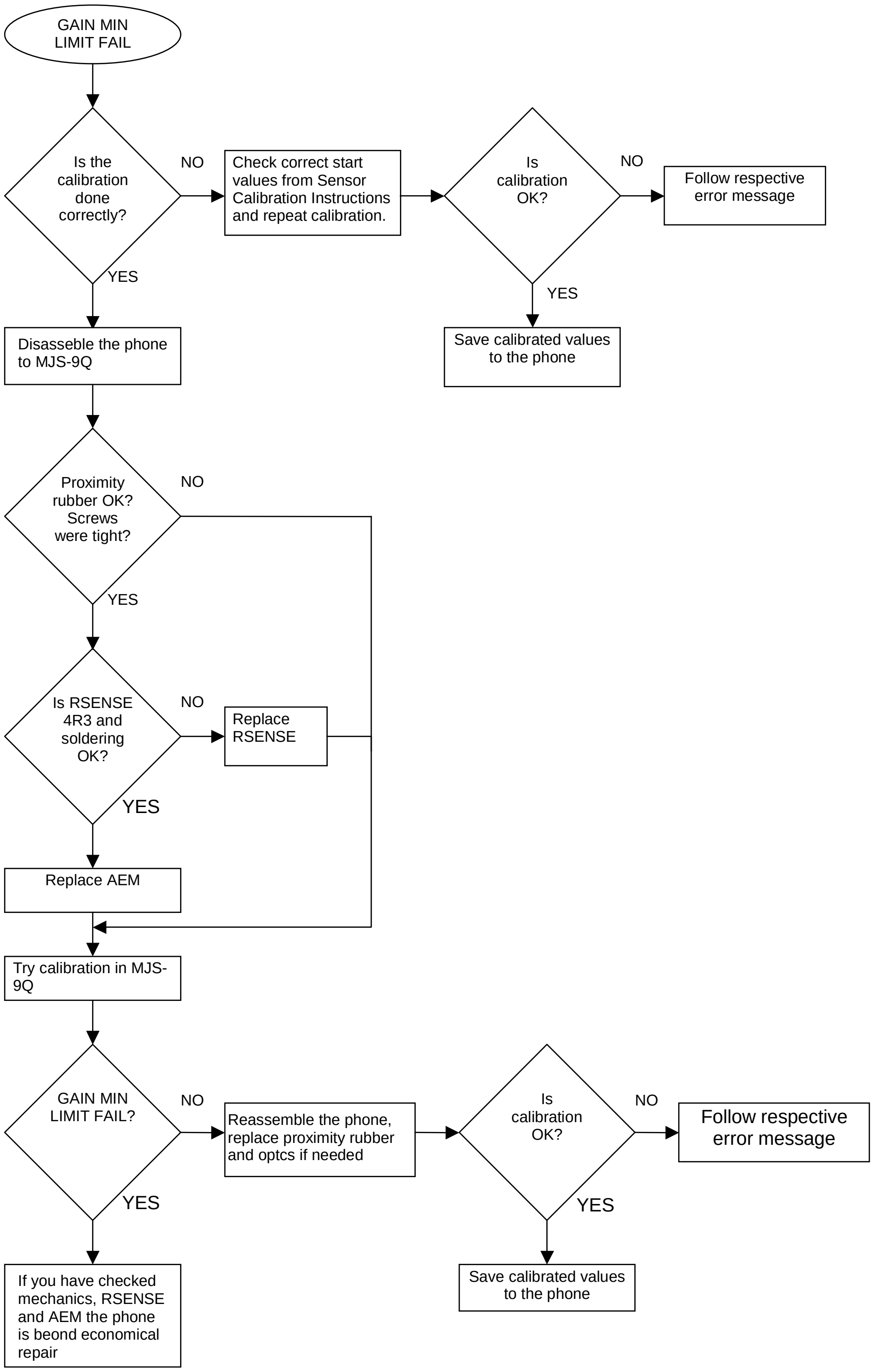

1 PD TX line: RSENSE R347 is connected to GND and IRED V334 to Vbatt
RX line: photodiode V335 is connected to GND. See figure 5.

2 If there is no obvious fault, replace first V335, then V334. Try calibration in the MJS-9Q in between.

## GAIN MIN LIMIT FAIL (0x0C)

There is a detection at each gain. IRED, RSENSE and photodiode are OK. Possible reasons are shortcut in RSENSE, missing optical insulator or wrong start values in calibration.

**Figure 8:** GAIN MIN LIMIT FAIL troubleshooting



## Ambient Light Detector

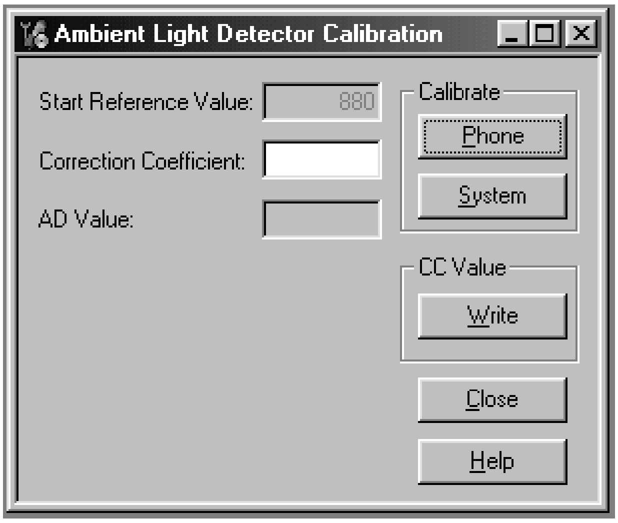
### General Notes

Ambient light sensor problems can be found during the calibration process or as problems with the display backlight and grip LEDs. The problem can also be in the NTC-resistor, which is used for temperature compensation of the ambient light detector. Before starting troubleshooting according to these instructions, it must be ensured that the problem really is in the ambient light detector. Other possibility is e.g. UI-module or backlight powering itself. This can be checked easily, because light sensor can be turned off.

Calibration of the Ambient Light Detector is needed always, when the phototransistor is replaced.

Calibration system is described in chapter “Service Software Instructions”.

**Figure 9: Ambient light detector calibration tool**

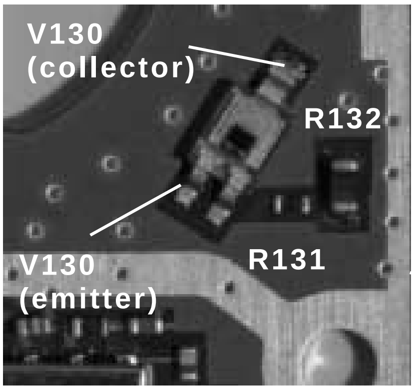


## Ambient Light Detector

From now on the Ambient Light Detector will be referred to as ALD.

Main components of the ALD are phototransistor SFH3410 (V130, 4864901), pull-up resistor 22kΩ (R131) and UEM (D190) ADC. There is also an NTC-resistor 47kΩ (R132, 1820037), which is used for temperature compensation. Temperature compensation is done by SW.

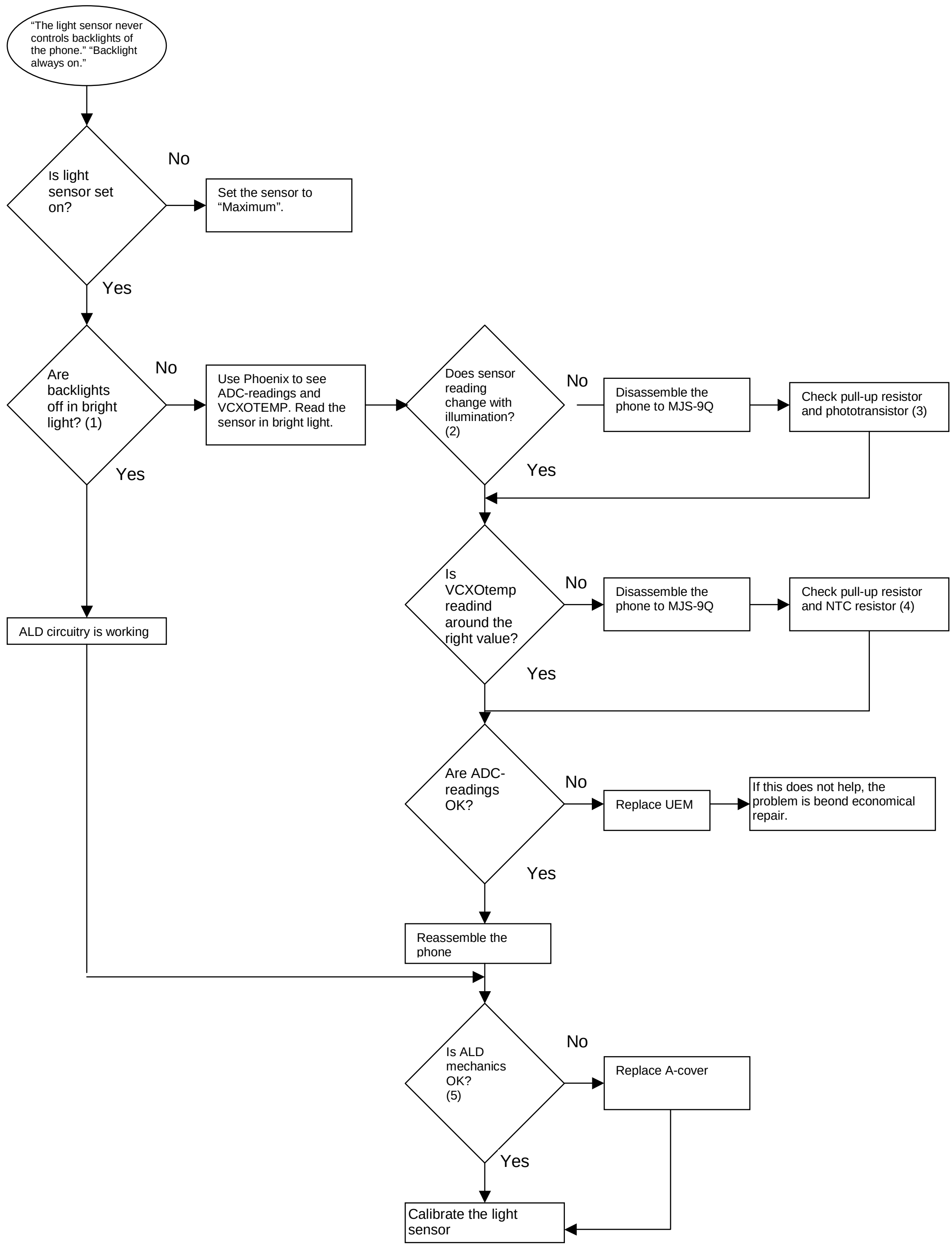
Figure 10: Ambient Light Sensor components



## Problems from the user point of view

"The sensor doesn't control backlights of the phone"

**Figure 11:** ALD troubleshooting 1



1. Set light sensor sensitivity to minimum. Illuminate sensor from close range with very bright light.

2. Sensor ADC-reading should be <500 in bright light and in total darkness >900.

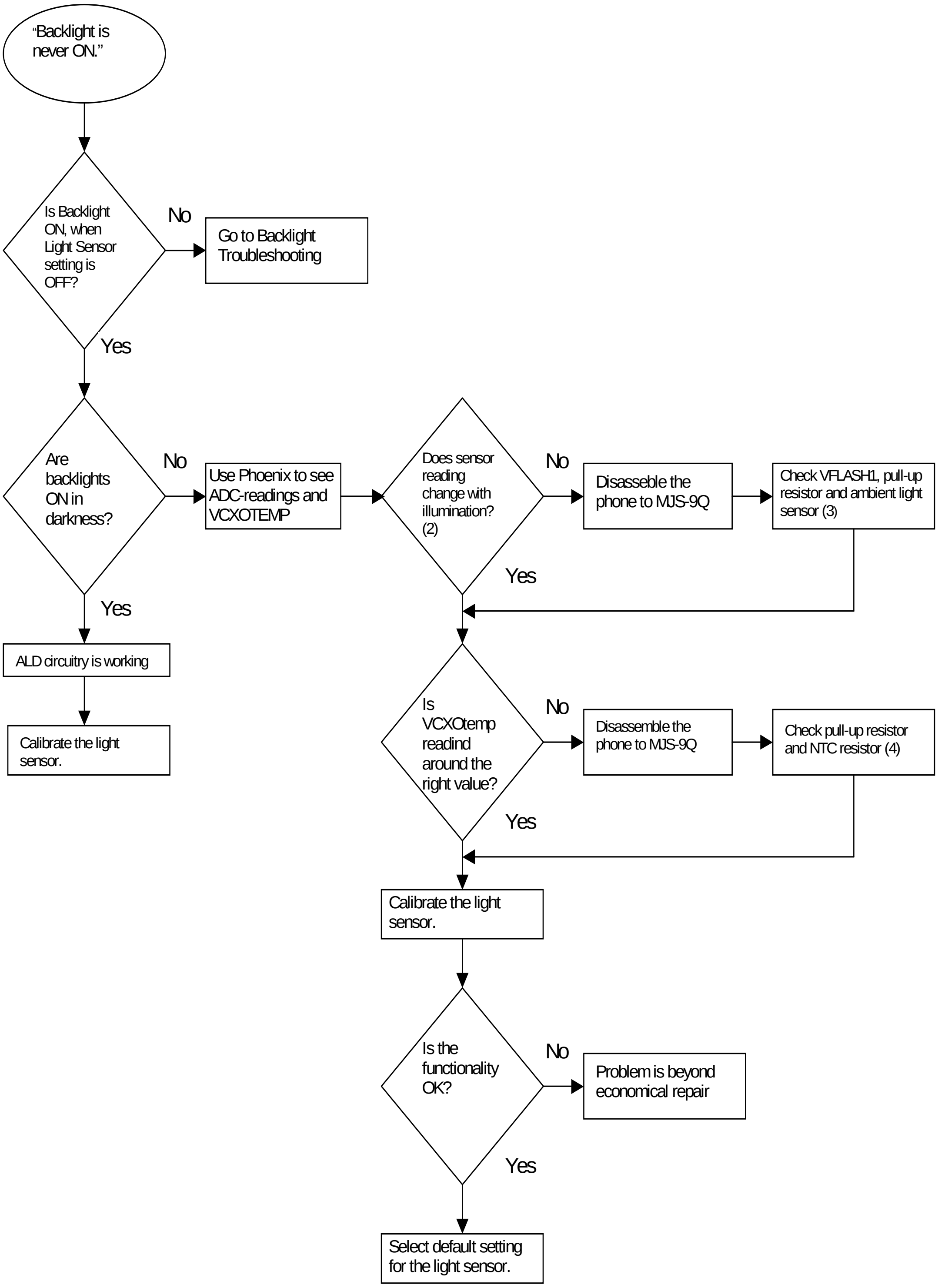
3. Check that resistance between sensor collector and VFLASH1 is 22k$\Omega$ (R131). Check that resistance between collector and emitter of the ambient light sensor changes, when illumination on the sensor (from ~5k$\Omega$ in high illuminance to ~500k$\Omega$ in total darkness) (V130). If phototransistor has to be replaced, the detector has to be calibrated. Calibration can be done only with TDS-11 light source.

4. NTC ( R132) resistance at room temperature is ~47k$\Omega$.

5. Check following points: is opening on the black paint in the A-cover covered; is light guide (integrated in the A-cover) broken?

## "Backlights are never ON"

**Figure 12:** ALD troubleshooting 2



1. Set light sensor sensitivity to “minimum”. Cover ALD window for example with a hand.

2. Sensor ADC-reading should be <500 in bright light and in total darkness >900.

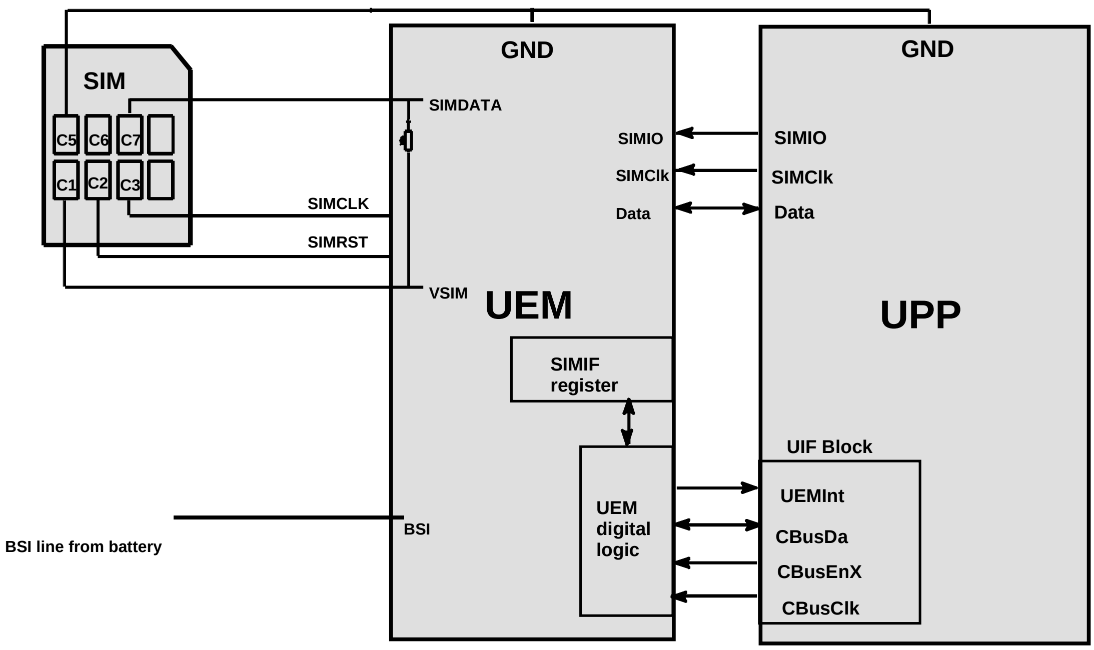
3. Vflash1, measured at pull-up resistor pin, should be 2.78V. Check that resistor R131 is placed, and it’s resistance is 22kΩ. Check that resistance between collector and emitter of the ambient light sensor changes, when illumination on the sensor (from ~5kΩ in high illuminance to ~500kΩ in total darkness). If phototransistor has to be replaced, the detector has to be calibrated. Calibration can be done only with TDS-11 light source.

4. NTC ( R132) resistance at room temperature is ~47kΩ.

## SIM card

The whole SIM interface locates in two chips UPP_WD2 and UEM. UEM contains the SIM interface logic level shifting. UPP provides SIMClk through UEM to the SIM. SIM interface supports both 3 V and 1.8 V SIMs. There is an EMI component on lg4 between the sim card and UEM which isn't shown in the below picture. One pullup resistor is also on board at simdata line, which isn't shown in the picture.

**Figure 13: UPP WD2 & UEM SIM connections**

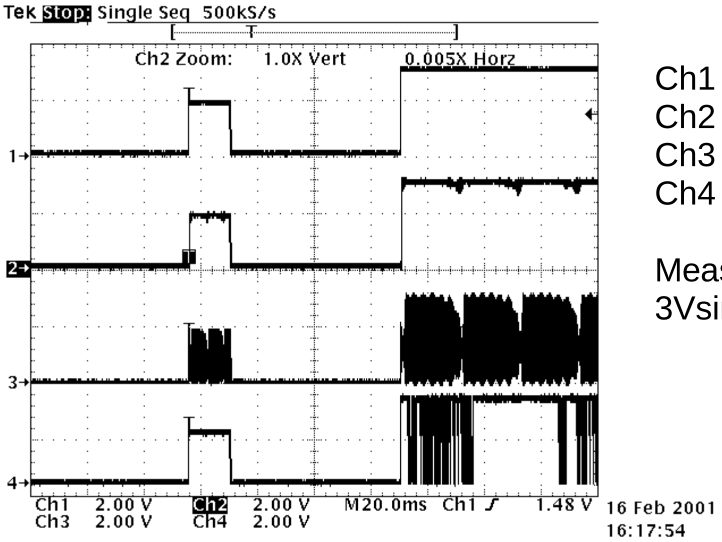



The SIM-power up/down sequence is generated in the UEM. This means that the UEM generates the RST signal to the SIM. Also the SIMCardDet signal is connected to UEM.

First the SW attempts to power up the SIM with 1.8 V. If this does not succeed power up is repeated with VSIM switched to 3 V.

The data communication between the card and the phone is asynchronous half duplex. The clock supplied to the card is in GSM system 1.083 MHz or 3.25 MHz. The data baudrate is SIM card clock frequency divided by 372 (by default), 64, 32 or 16.

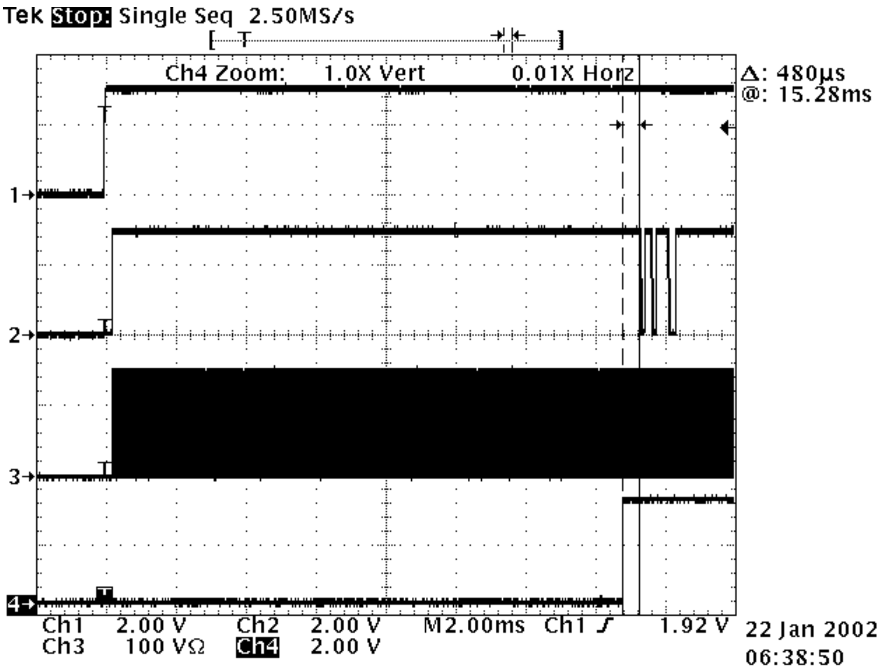
**Figure 14: SIM Power Up.**




Ch1 Vsim
Ch2 Reset
Ch3 Clock
Ch4 I/O

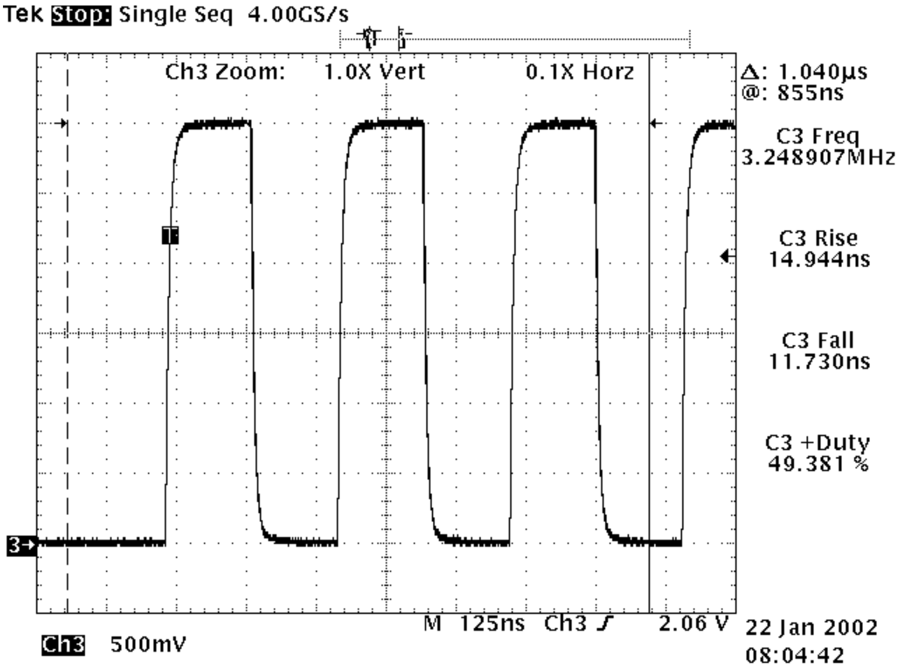
Measured with
3Vsim

**Figure 15:** SIM answer to reset

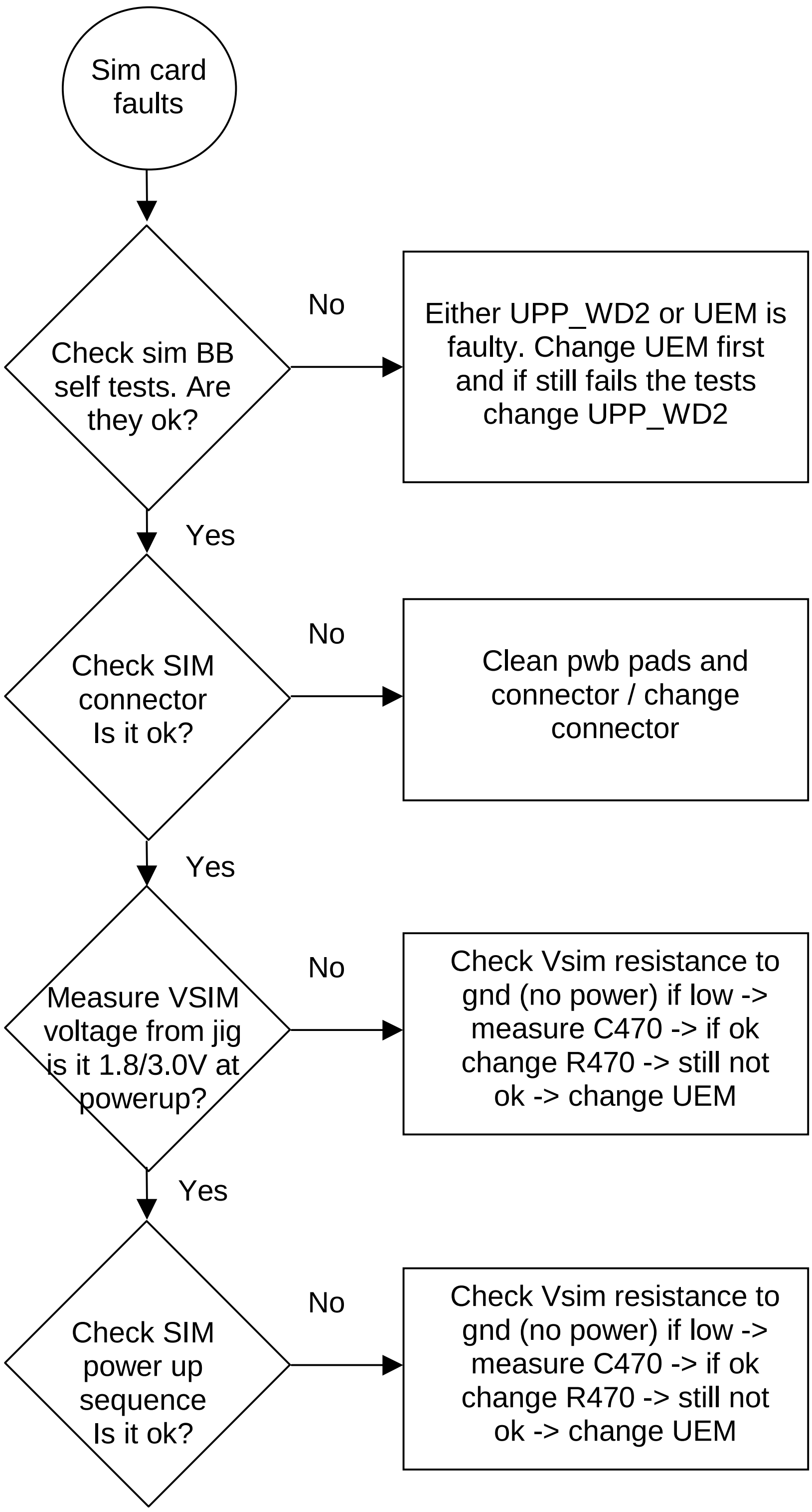



-Ch1 Vsim
-Ch2 sim_data
–Ch3 sim_clk
–Ch4 sim_reset

**Figure 16:** SIM Clk 3.25MHz

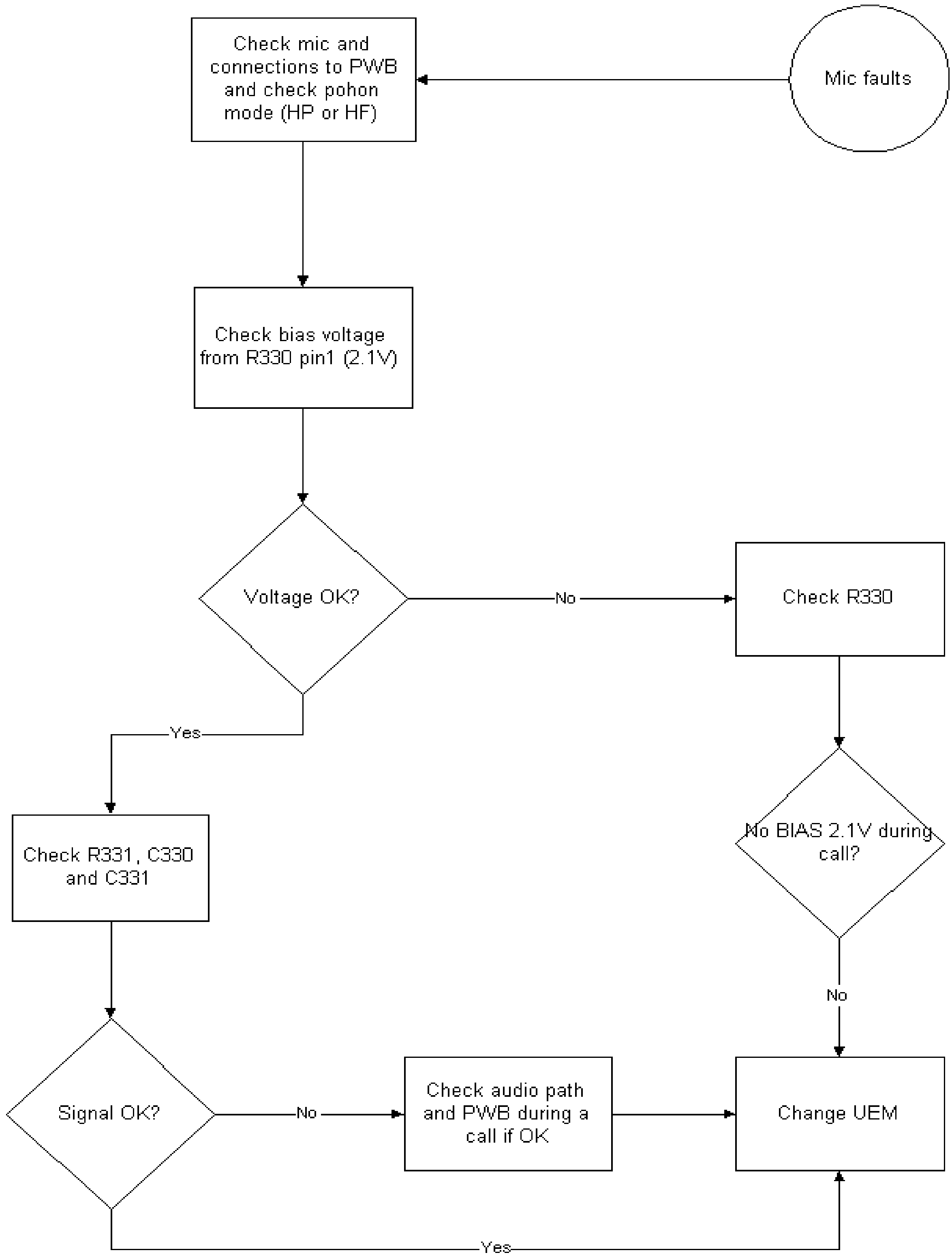


**"Insert SIM Card" in device display allthough card is inserted**



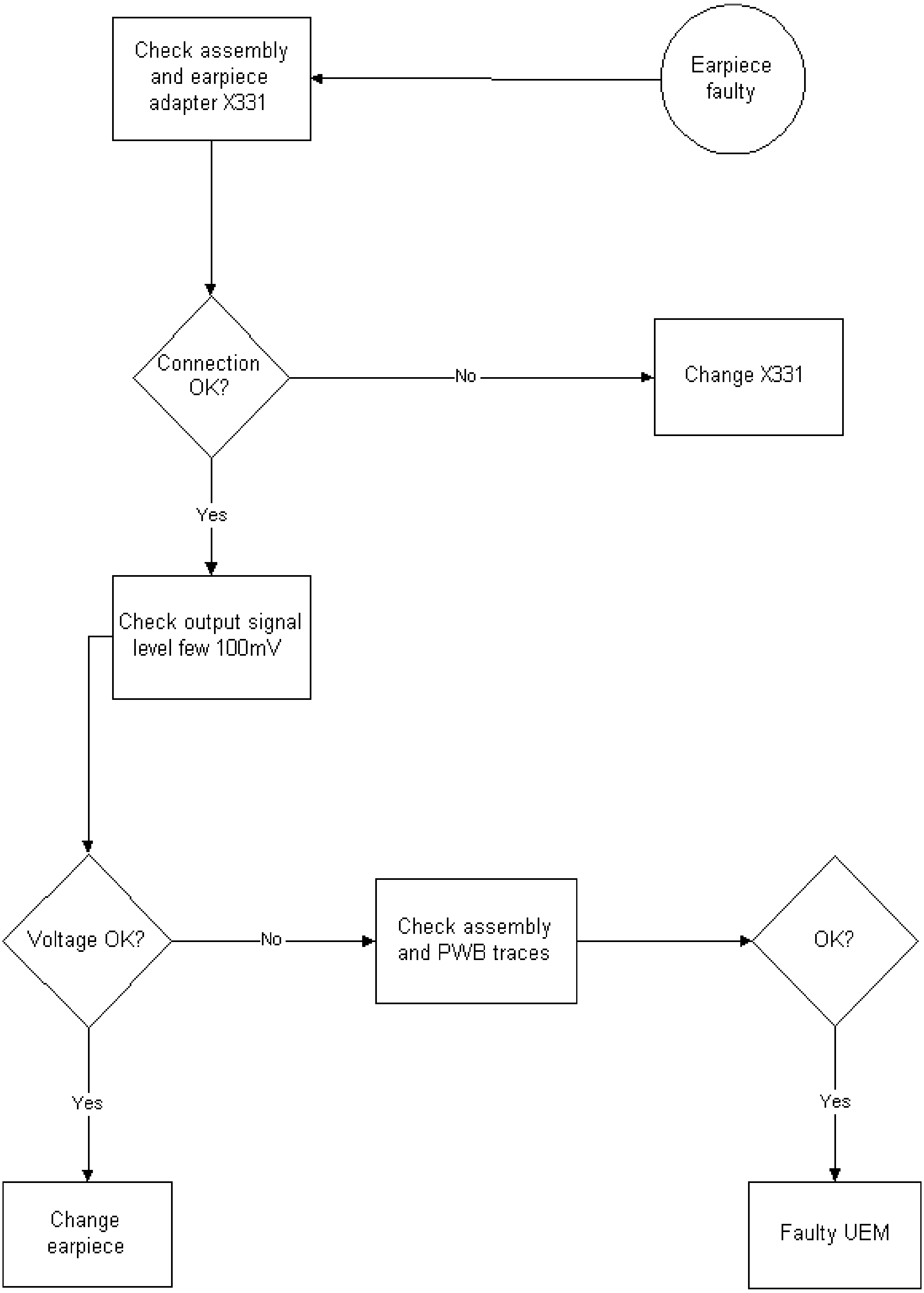
# Audio

## Microphone



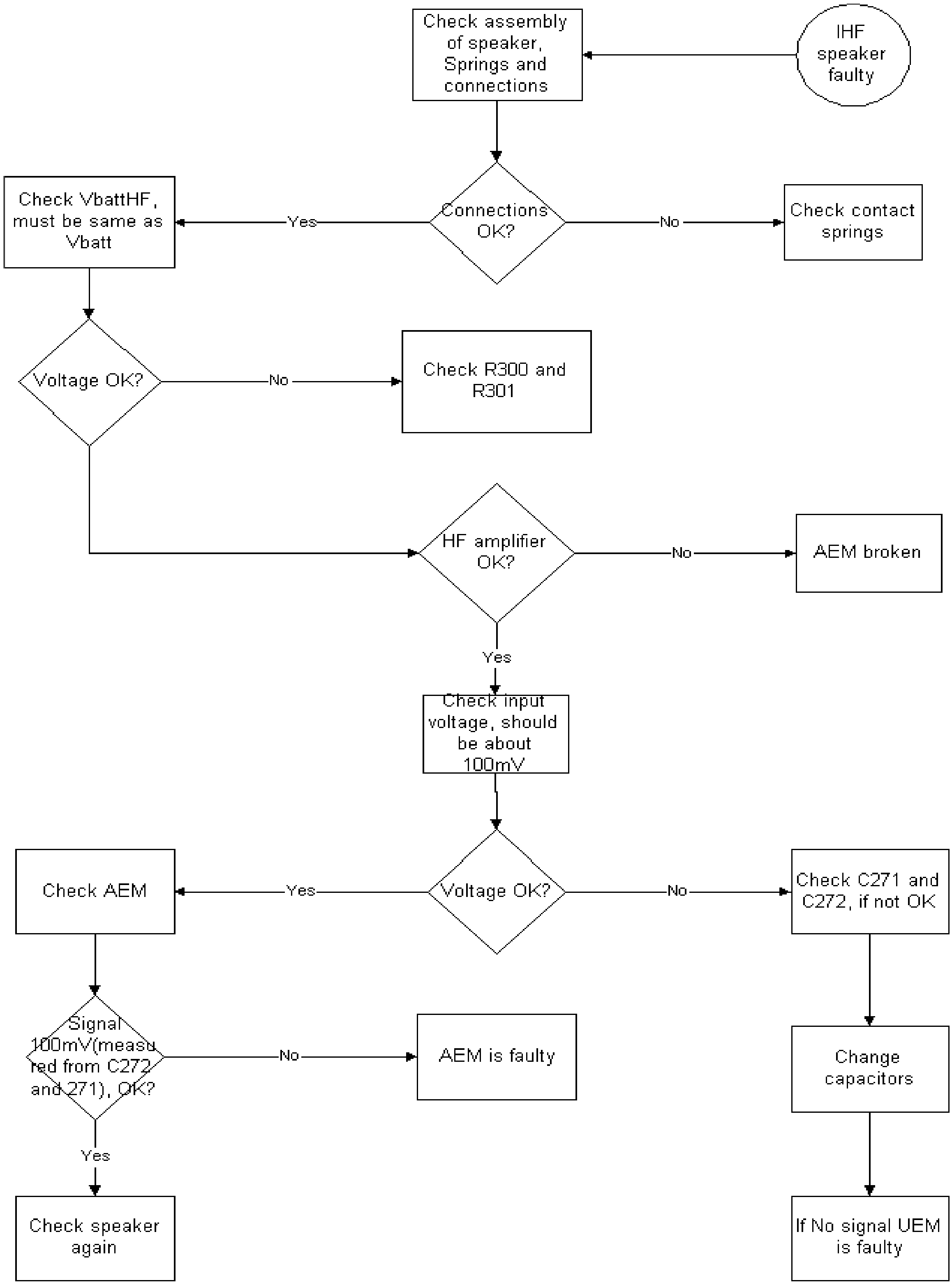
**Earpiece**

Check that holes are not covered.

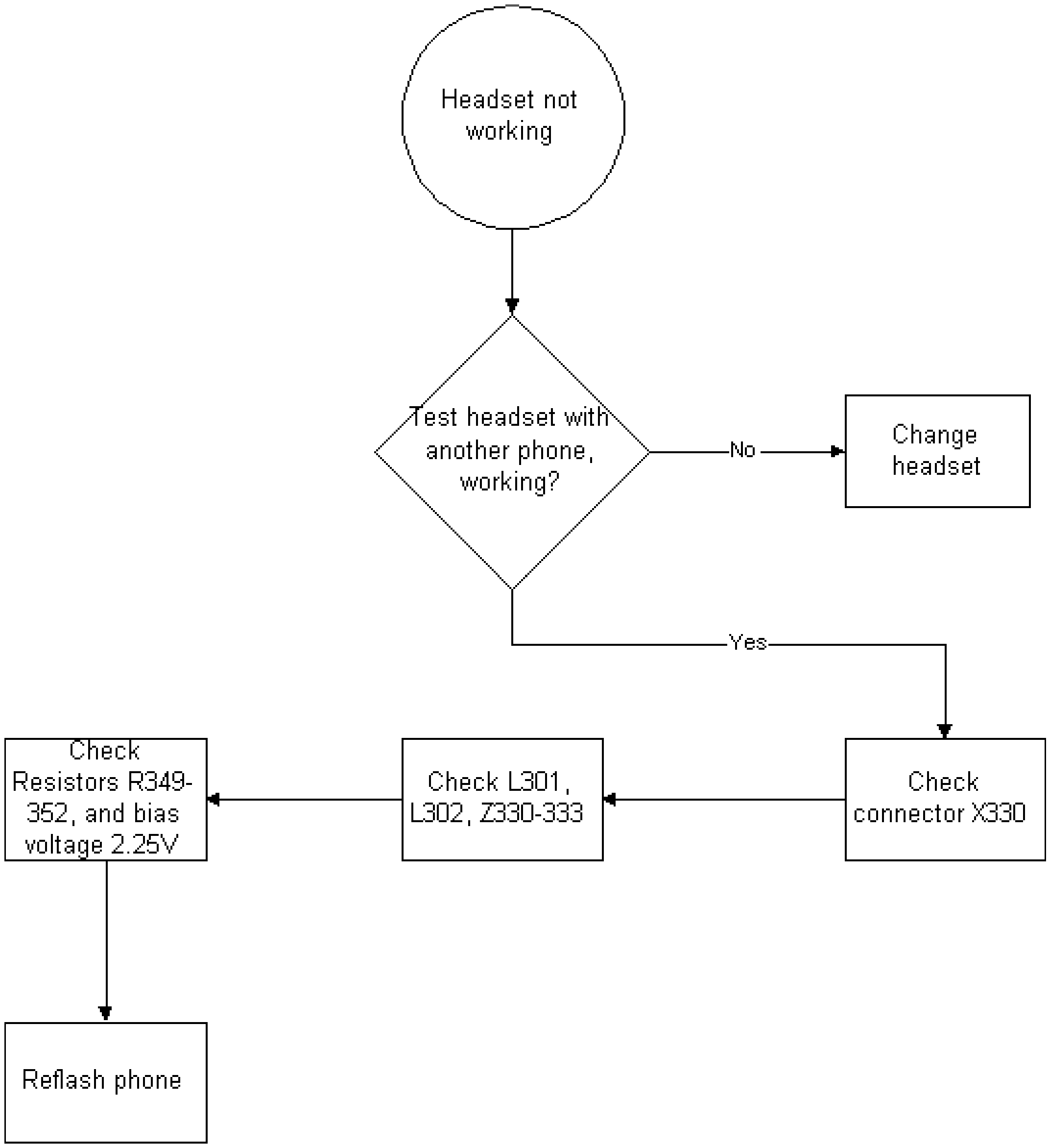


## IHF

In the case of IHF fault the reason can be found from integrated hands free itself or proximity sensor. Proximity sensor disables IHF if phone is too near some object. It is possible if the proximity sensor is faulty IHF can not be enabled even if it is working fine.



## Accessory detection troubleshooting

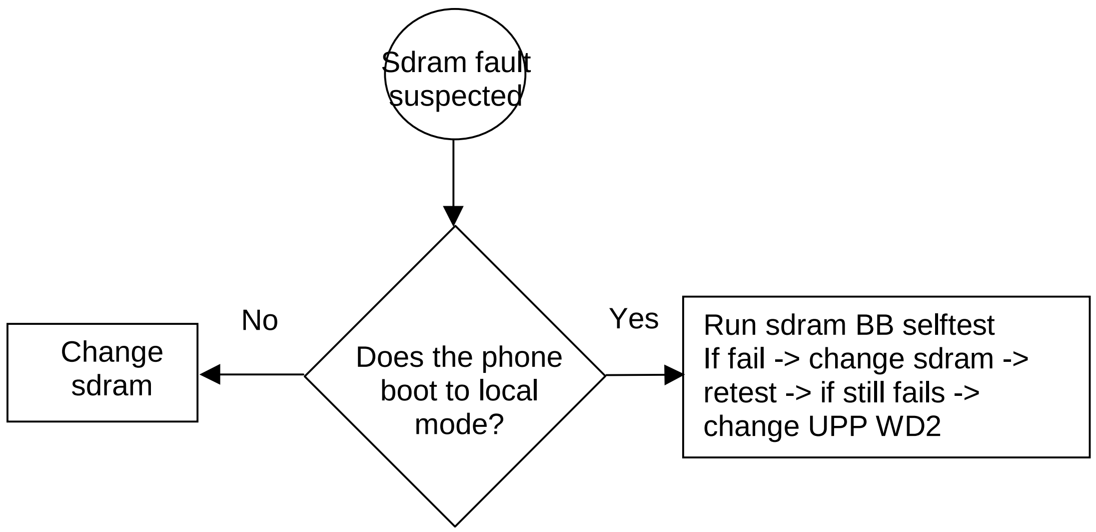


## Memory troubleshooting

Most memory related errors are found through flashing the device, flashing the device is therefore recommended before any of the steps described in this chapter. Check flashing troubleshooting section first.

There are however a few memory related errors that cannot be found through flashing.

- SDRAM partially damaged
  This can mean that the sdram component itself is partially damaged and all the memory locations cannot be successfully accessed or there is a soldering problem somewhere either under UPP or sdram.




- flash1 (D310) is partially/totally damaged
  During flashing the manufacturer, device and revision id's are read, but flashing is done based on id's of the flash0 (D311). This means that one cannot see any error messages displayed on Phoenix window during flashing if flash1 is failing. Id's are however displayed on the Phoenix window and successful read of flash1 id's can be checked from there. One good way to test flash1 functionality is to format it(from Phoenix).

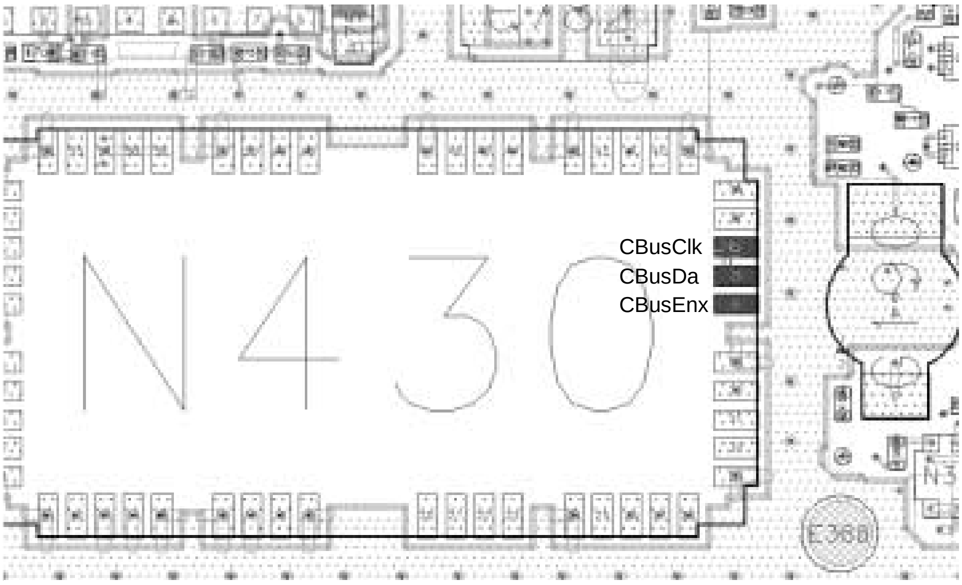
## Baseband serial interface troubleshooting

### CBUS

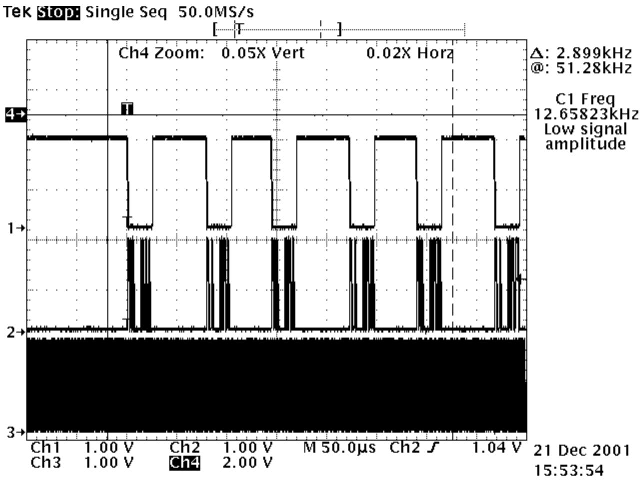
CBUS is a three wire serial interface between main baseband components. The bus consists of data, clock and bus_enable signals. In NHL-2NA the bus is connected from UPP WD2 to AEM, UEM and the BT module. UPP_WD2 takes care of controlling the traffic on the bus.

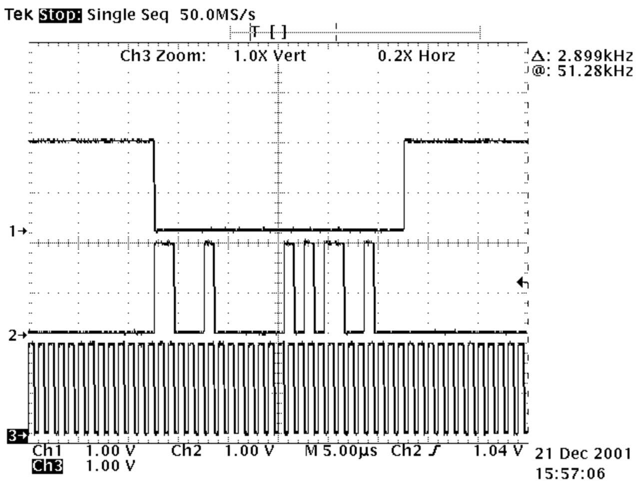
If the interface is faulty from the UPP WD2's end the phone will not boot properly as powering configurations do not work. Traffic on the bus can be monitored from three pins on the BT module. Pins are shown below.

**Figure 17:** CBUS measuring points



In the pictures below CBUS traffic at bootup is shown. CbusEnx is connected to Ch1, Cbus Da to Ch2 and CbusClk to Ch3. The lower is just a more detailed picture of a write command (to AEM).




However, if you are able to get the phone to boot up and can reach Phoenix BB self tests it is possible to test the functionality of each component attached to Cbus. Use:

- ST_AEM_CBUS_IF_TEST to test AEM Cbus interface
- ST_UEM_CBUS_IF_TEST to test UEM Cbus interface
- ST_LPRF_IF_TEST to test Bluetooth Cbus interface

If an error is found testing any of the abowe components you should replace or re-solder the failing component.

### FBUS

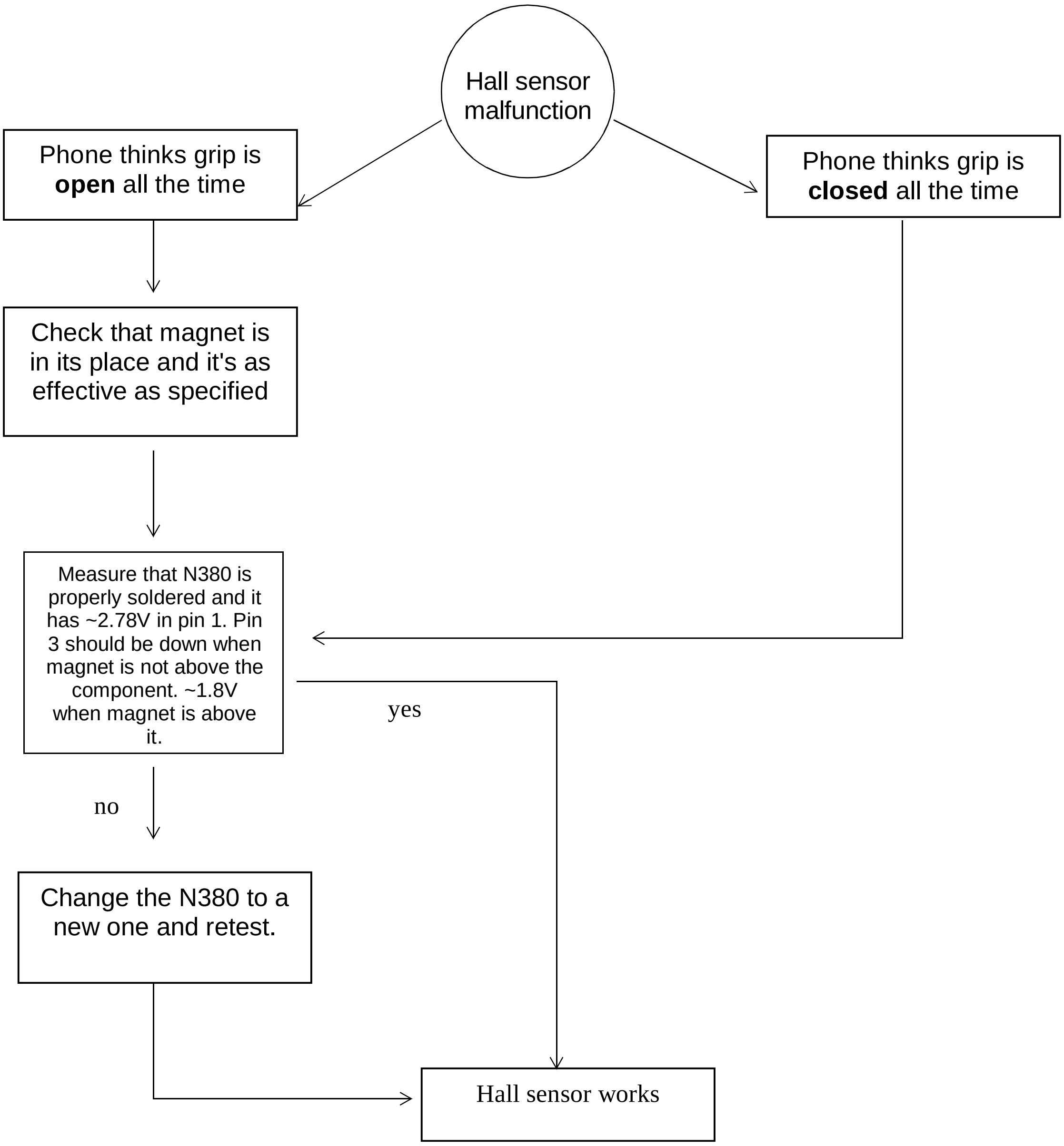
FBUS is a two wire RX and TX interface between UPP and flash/test interface. The bus goes through UEM which adjusts the voltage levels to suit UPP_WD2. The interface voltage level on the phone flash/test pad pattern is 2.78V and on the UPP WD2 end it is 1.8V. The functionality of this interface should not affect the device boot into NORMAL, LOCAL nor TEST modes. Phoenix tests can be performed through MBUS interface in the case of a failure in FBUS interface. Flashing is not possible if there is a problem in FBUS interface.

### MBUS

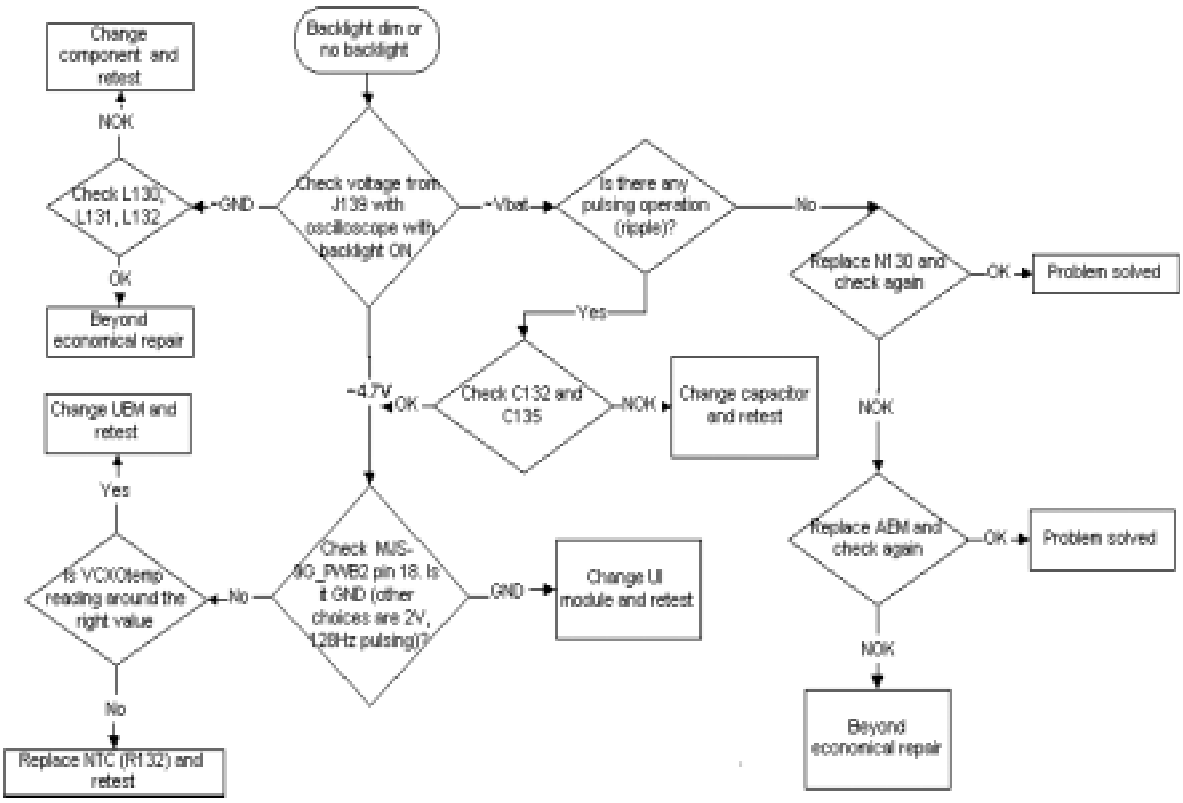
MBUS is a two wire RX and TX interface between UPP and UEM. From UEM the interface continues to flash/test interface as a one wire interface. UEM adjusts the voltage levels. The interface voltage level on the phone flash/test pad pattern is 2.78V and on the UPP WD2 end it is 1.8V. MBUS traffic between UPP WD2 and UEM can be tested with PHOENIX (ST_MBUS_RX_TX_LOOP_TEST). Flashing is not possible if there is a problem in MBUS.

## Hall sensor troubleshooting

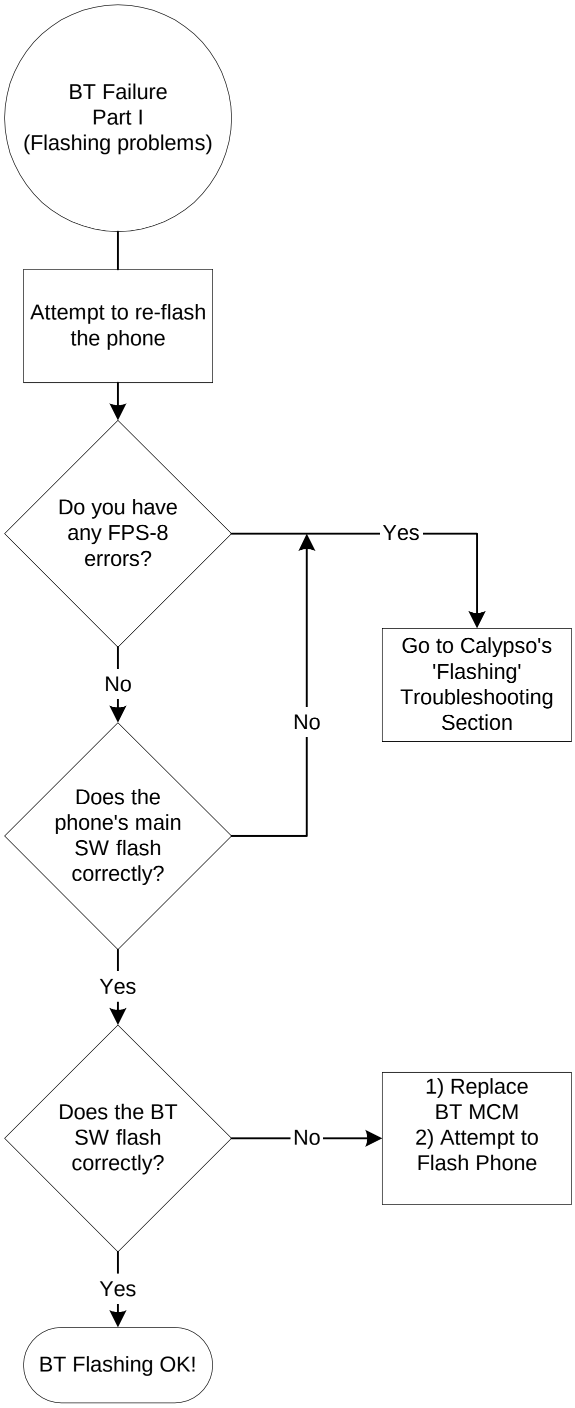
There might be two kind of malfunction concerning Hall sensor; The out put of the Hall sensor keeps to high or low regardless the position of the magnet.

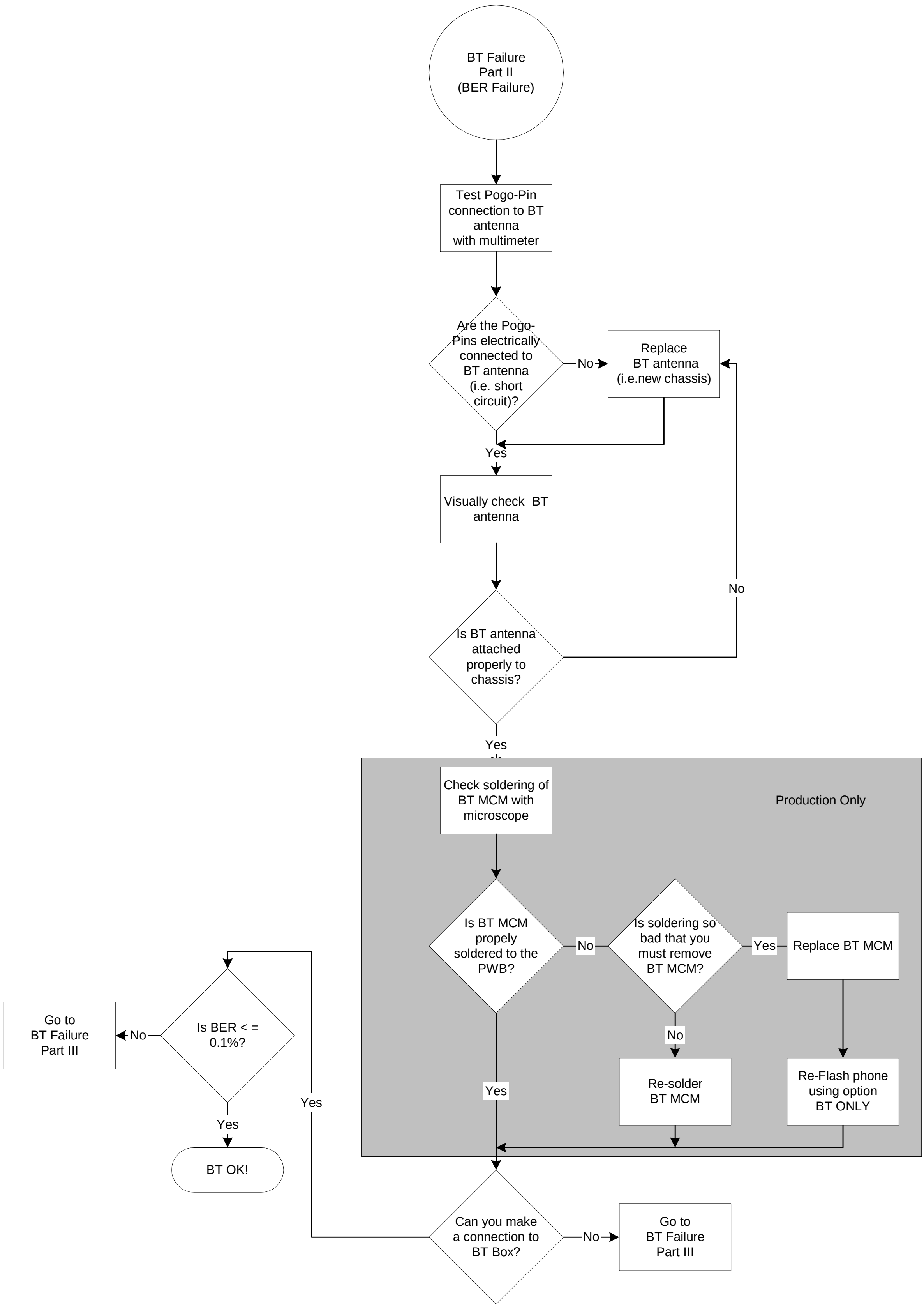


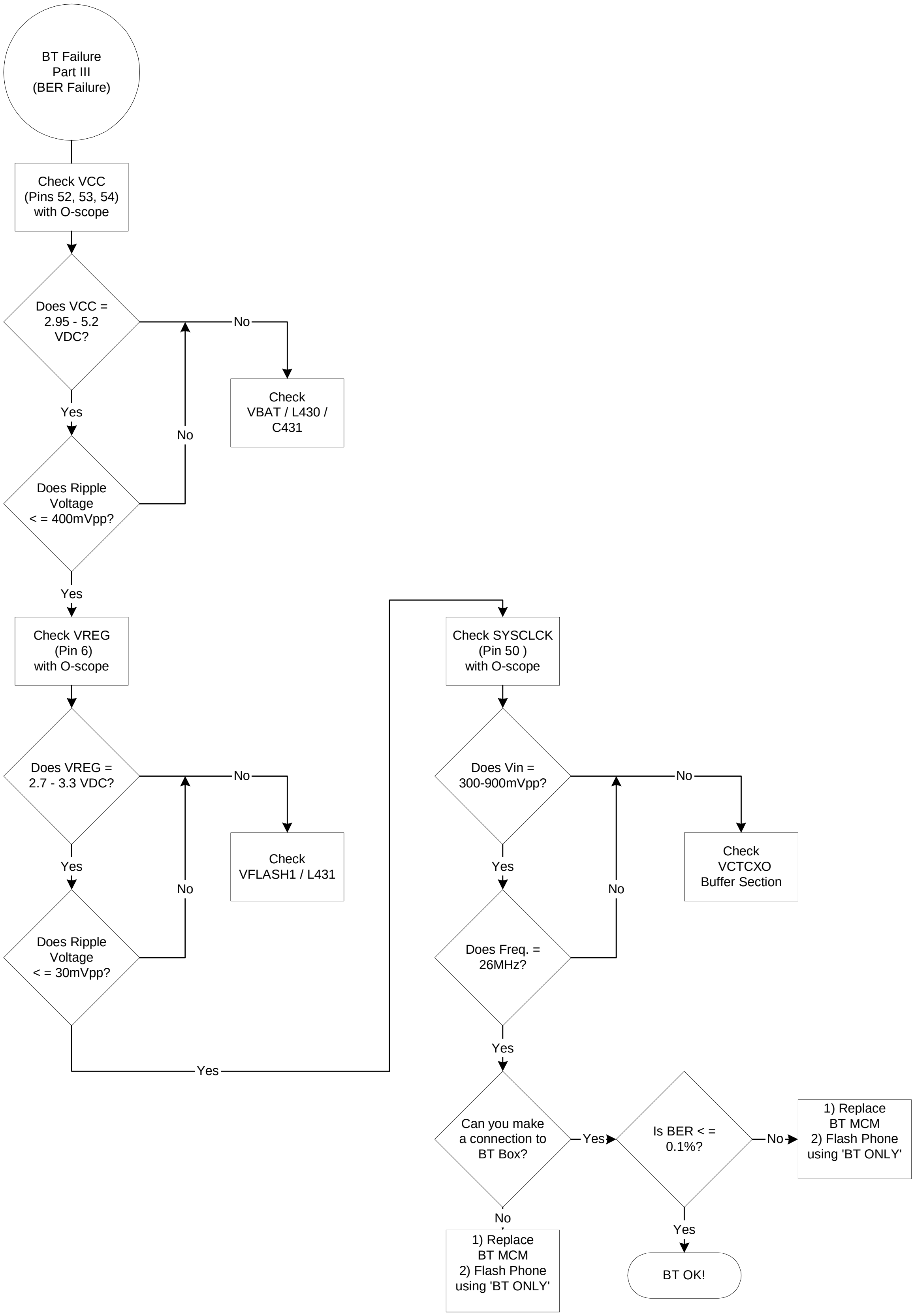
## Display backlights troubleshooting



## Bluetooth troubleshooting




BT Failure
Part II
(BER Failure)
Test Pogo-Pin connection to BT antenna with multimeter
Are the Pogo-Pins electrically connected to BT antenna (i.e. short circuit)?
No
Replace BT antenna (i.e.new chassis)
Yes
Visually check BT antenna
Is BT antenna attached properly to chassis?
No
Yes
Production Only
Check soldering of BT MCM with microscope
Is BT MCM propely soldered to the PWB?
No
Is soldering so bad that you must remove BT MCM?
Yes
Replace BT MCM
No
Re-solder BT MCM
Re-Flash phone using option BT ONLY
Yes
Can you make a connection to BT Box?
No
Go to BT Failure Part III
Yes
Is BER < = 0.1%?
No
Go to BT Failure Part III
Yes
BT OK!


BT Failure
Part III
(BER Failure)
Check VCC
(Pins 52, 53, 54)
with O-scope
Does VCC =
2.95 - 5.2
VDC?
No
Check
VBAT / L430 /
C431
Yes
No
Does Ripple
Voltage
< = 400mVpp?
Yes
Check VREG
(Pin 6)
with O-scope
Does VREG =
2.7 - 3.3 VDC?
No
Check
VFLASH1 / L431
Yes
No
Does Ripple
Voltage
< = 30mVpp?
Yes
Check SYSCLCK
(Pin 50 )
with O-scope
Does Vin =
300-900mVpp?
No
Check
VCTCXO
Buffer Section
Yes
No
Does Freq. =
26MHz?
Yes
Can you make
a connection to
BT Box?
Yes
Is BER < =
0.1%?
No
1) Replace
BT MCM
2) Flash Phone
using 'BT ONLY'
No
1) Replace
BT MCM
2) Flash Phone
using 'BT ONLY'
Yes
BT OK!

# Needed actions if ASIC is changed

## UEM changed

If UEM is changed baseband calibrations should be made. IMEI has to be rebuilt to the phone.

## AEM changed

If AEM is changed proximity and ambient light sensor calibrations should be achieved.

## UPP_WD2 changed

Device has to be reflashed.

## Flash0 changed

IMEI has to be reprogrammed. Has to be flashed (naturally). IMEI has to be rebuilt to the phone.

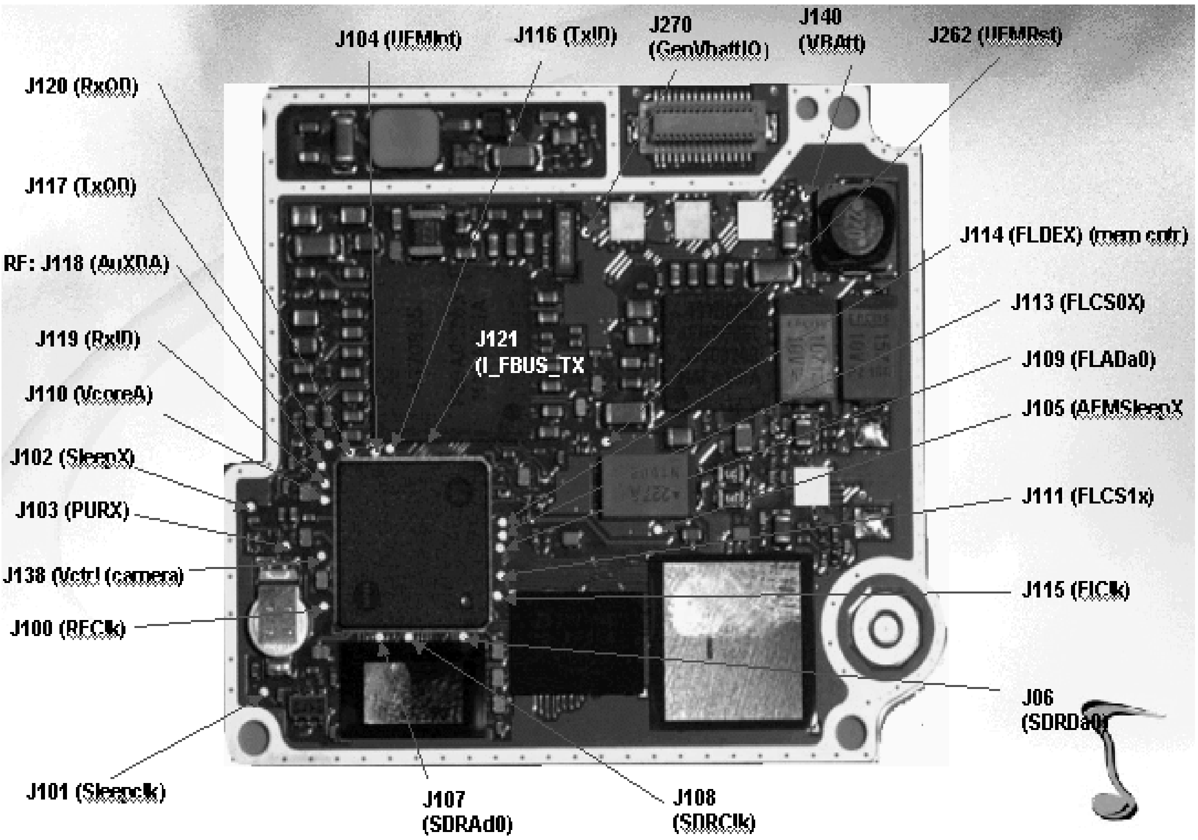
## RF component changed

If any RF component changed, RF calibration(tuning) has to be done.

# Test points and pin orders

## Test points in BaseBand area (LG4_06_02)

| | |
|---|---|
| J100 | RFclk |
| J101 | Sleepclk |
| J102 | SleepX |
| J103 | PURX |
| | |
| J116 | Txid |
| J117 | Txqd |
| J118 | Auxda |
| J119 | Rxid |
| J120 | Rxqd |
| | |
| J104 | UEMint |
| J105 | AEMSleep |
| J110 | DSPVcc |
| | |
| J106 | SDRda0 |
| J107 | SDRad0 |
| J108 | SDRclk |
| J109 | FLDa0 |
| | |
| J111 | FLXS1x |
| J113 | FLCS0x |
| J114 | FLOEX |
| J115 | FLClk |
| | |
| J121 | I_FBUS_TX |
| | |
| J381 | Vbatt |
| | |
| J270 | GenVbattIO |
| J262 | Refen |


J104 (UEMInt)
J116 (TxIP)
J270
(GenVbattIO)
J140
(VBAtt)
J262 (UEMRst)
J120 (RxQD)
J117 (TxQD)
RF: J118 (AuXDA)
J119 (RxID)
J110 (VcoreA)
J102 (SleepX)
J103 (PURX)
J138 (Vctrl (camera)
J100 (RFClk)
J101 (Sleepclk)
J121
(I_FBUS_TX
J114 (FLDEX) (mem cntr)
J113 (FLCS0X)
J109 (FLADa0)
J105 (AEMSleepX
J111 (FLCS1x)
J115 (FIClk)
J06
(SDRDa0)
J107
(SDRAd0)
J108
(SDRClk)

# Connectors pin order

## UI-connector

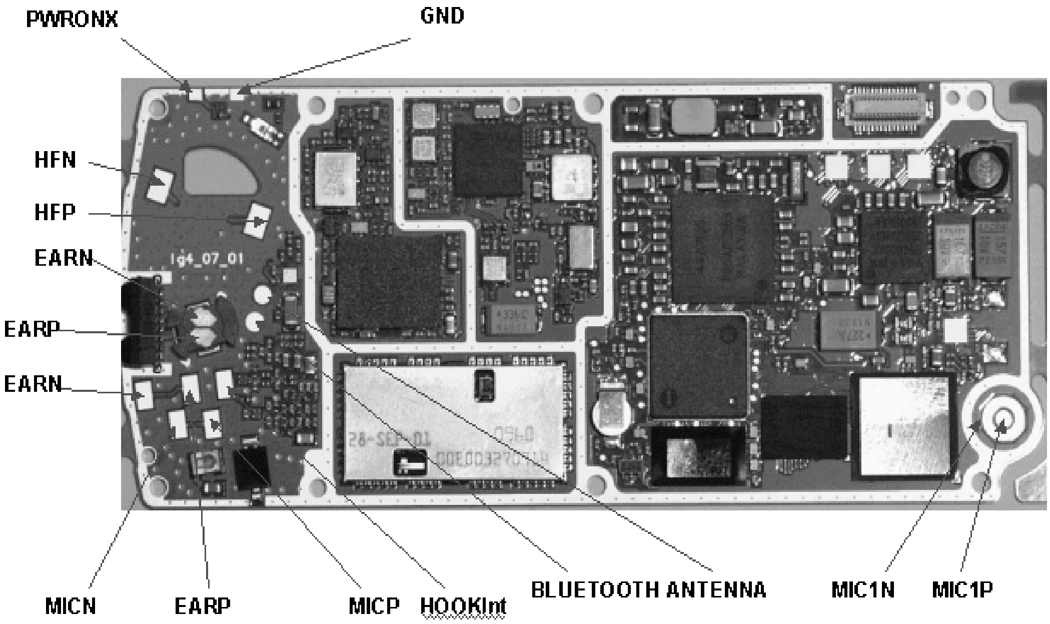
| Pin no. | Signal name | Type | Typical | Unit | Description |
|---|---|---|---|---|---|
| 1 | VDD | IN | 2.78 | V | Voltage supply |
| 2 | GND | | 0 | V | System ground |
| 3 | D4 | IN<br>OUT | | V | Data to write |
| | | | | V | Data to read |
| 4 | D0 | IN<br>OUT | | V | Data to write |
| | | | | V | Data to read |
| 5 | A0 | IN | | V | H: data<br>L: command |
| 6 | GND | | 0 | V | System ground |
| 7 | VDDI | IN | 1.8 | V | Logic voltage supply |
| 8 | D1 | IN<br>OUT | | V | Data to write |
| | | | | V | Data to read |
| 9 | D2 | IN<br>OUT | | V | Data to write |
| | | | | V | Data to read |
| 10 | D3 | IN<br>OUT | | V | Data to write |
| | | | | V | Data to read |
| 11 | Rocker3 | | 200 | mOhm | |
| 12 | Rocker2 | | 200 | mOhm | |
| 13 | GND | | 0 | V | System ground |
| 14 | Rocker5 | | 200 | mOhm | |
| 15 | Rocker4 | | 200 | mOhm | |
| 16 | Rocker1 | | 200 | mOhm | |
| 17 | $V_{LED}$+ | IN/<br>OUT | 4.5 | V | LED, positive terminal |
| 18 | $V_{LED}$- | IN/<br>OUT | 0 | V | LED, negative terminal |
| 19 | Row1 | IN/<br>OUT | | Ohm | Tracking resistance |
| | | | | mA | Drive current |
| 20 | Row0 | IN/<br>OUT | | Ohm | Tracking resistance |
| | | | | mA | Drive current |
| | | | | mA | Drive current |

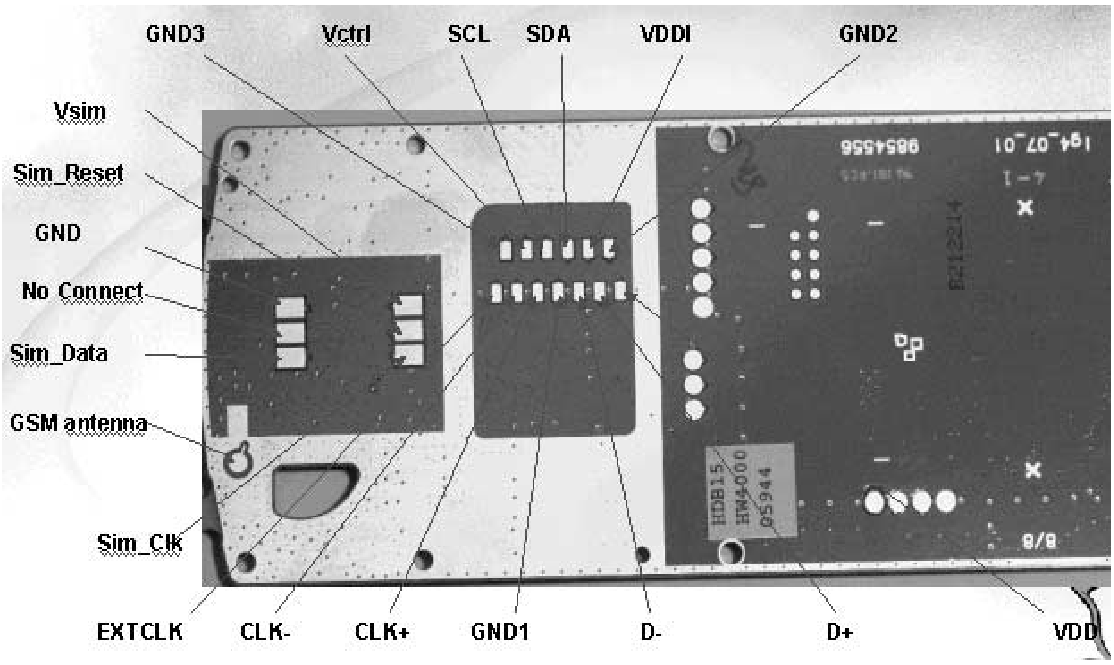
| | | | | | |
|---|---|---|---|---|---|
| 21 | Col1 | IN/<br>OUT | | Ohm | Tracking resistance |
| | | | | mA | Drive current |
| 22 | Col0 | IN/<br>OUT | | Ohm | Tracking resistance |
| | | | | mA | Drive current |
| 23 | GND | | 0 | V | System ground |
| 24 | RESX | IN | | V | Reset<br>(active low) |
| 25 | D5 | IN<br>OUT | | V | Data to write |
| | | | | V | Data to read |
| 26 | D6 | IN<br>OUT | | V | Data to write |
| | | | | V | Data to read |
| 27 | D7 | IN<br>OUT | | V | Data to write |
| | | | | V | Data to read |
| 28 | GND | | 0 | | System ground |
| 29 | RDX | IN | | | L: read<br>(active low) |
| 30 | WRX | IN | | | L: Write<br>(active low) |

## Board to board connector

See System Module LG4 and Grip Module LS4".

## Pin order of spring connectors



# RF Troubleshooting

## Introduction

Measurements should be done using Spectrum Analyzer with high-frequency 1kW (20:1) passive probe (LO-/reference frequencies and RF-power levels) and Oscilloscope with a 10:1 probe (DC-voltages and low frequency signals).

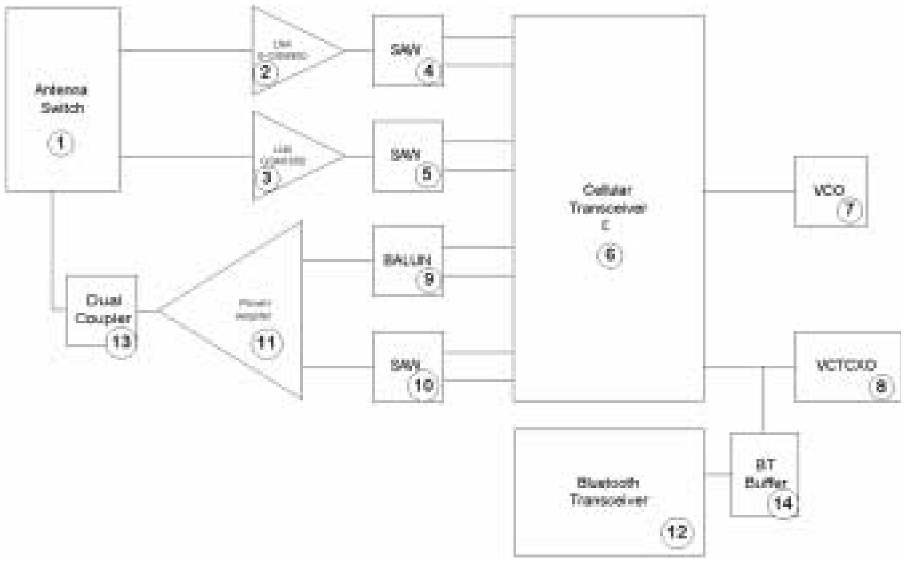
Please note that the grounding of the PA-module is directly below PA-module so it is difficult to check or change. **Most RF semiconductors are static discharge sensitive!** So ESD protection must be taken during repair (ground straps and ESD soldering irons). The Hagar IC is moisture sensitive so parts must be pre-baked prior to soldering.

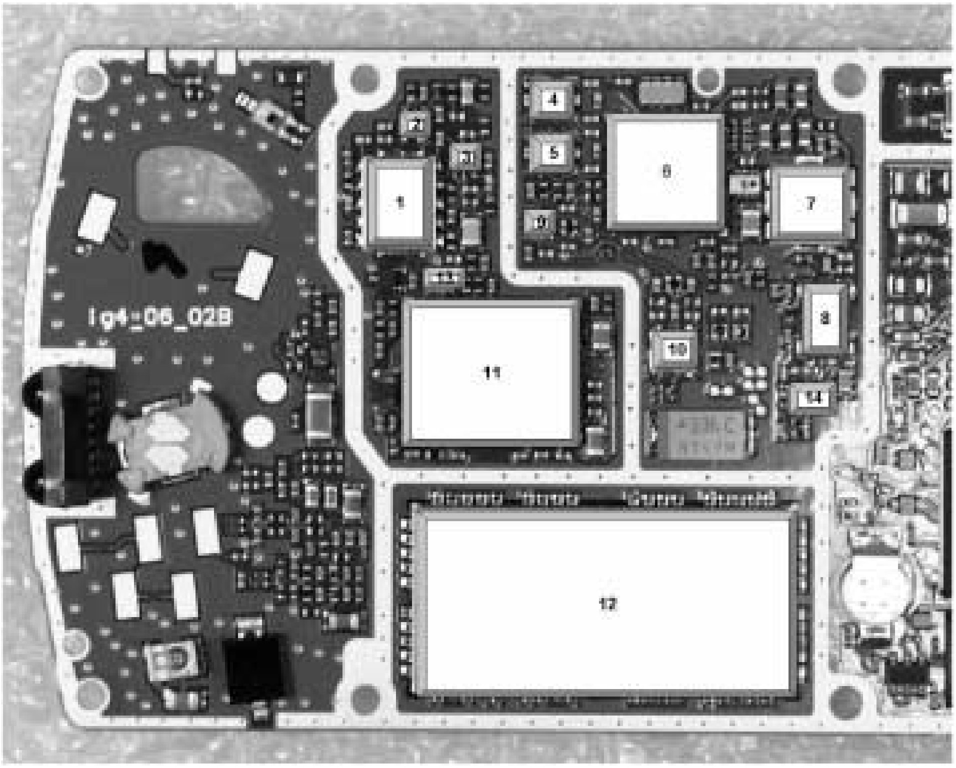
Apart from key-components described in this document here are a lot of discrete components (resistors, inductors and capacitors) which troubleshooting is done by checking if soldering of the component is done properly, for factory repairs (checking if it is missing from PCB). Capacitors can be checked 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 varies due to different measuring equipment or different grounding of the used probe.

All tuning must be done with Phoenix Service Software, version **02.90.001**, or later.

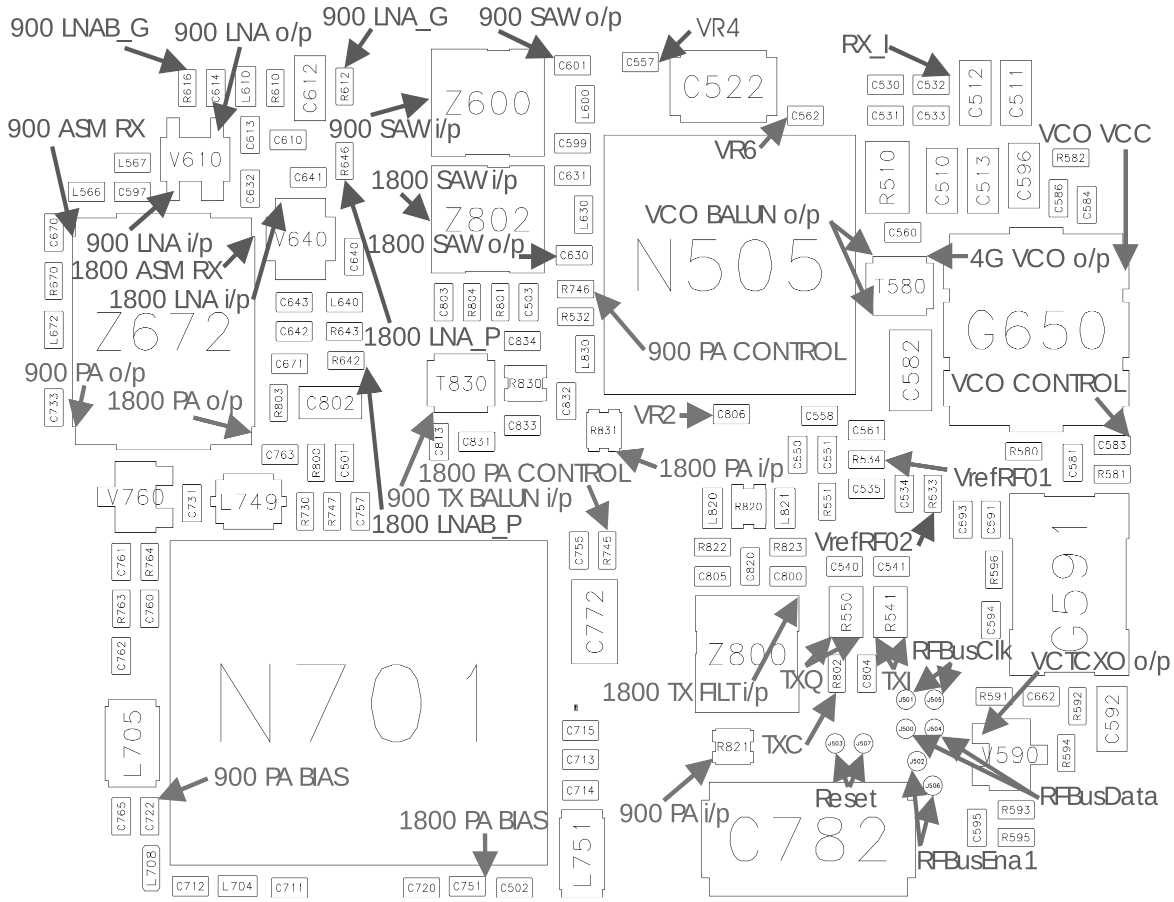
## RF Key component placement



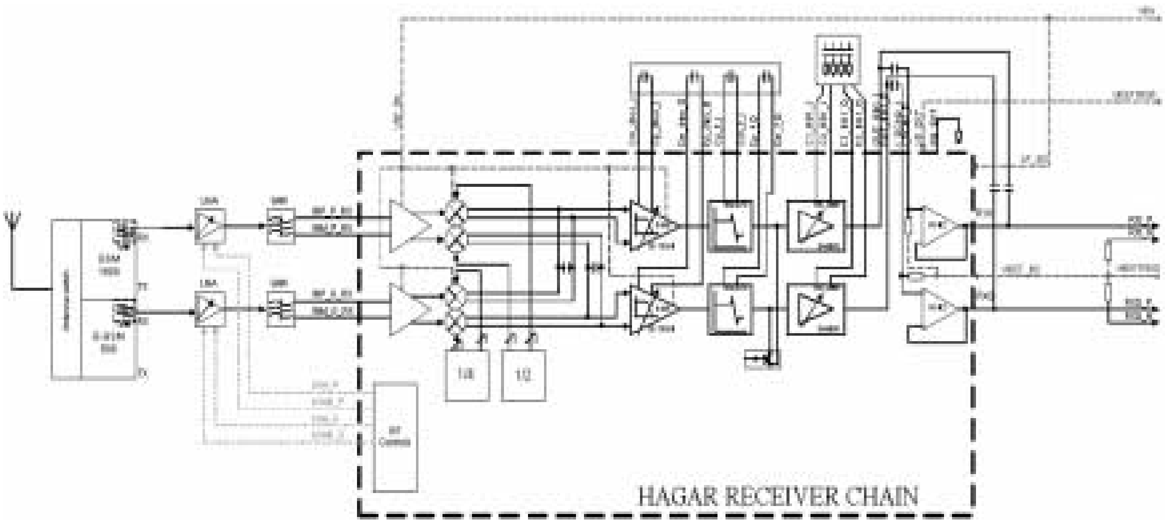

  

## Fault finding test point locations



## Receiver

### General description




The receiver is a direct-conversion, dual-band linear receiver. RF signal energy gathered by the antenna is fed via the antenna switch module to the 1st RX bandpass SAW filters and MMIC LNAs. The RF antenna switch module provides for upper- and lower-band operation. The signal having been amplified by the LNA is then fed to 2nd RX bandpass SAW filters. Both of these 2nd RX bandpass SAW filters have UNBAL/BAL configuration to achieve the balanced feed for HAGAR. The discrete LNAs have three gain levels. The first one is maximum gain, the second one is about -30dB ( GSM1800 ) and –25dB ( E-GSM900 ) below maximum gain and the last one is off state. The LNA gain selection is controlled directly by HAGAR.

The performance of the RX bandpass SAW filters are mainly responsible for defining the receiver's blocking characteristics against spurious signals outside passband and the protection against spurious responses.

The differential RX signal is amplified and mixed directly down to BB frequency in HAGAR. The LO signal is generated with external VCO. This VCO signal is divided by 2 ( GSM1800 ) or by 4 ( E-GSM900 ). The PLL and dividers are internal to the HAGAR IC. From the mixer output to ADC input RX signal is divided into I- and Q-signals. Accurate phasing is generated in LO dividers. After the mixer DTOS amplifiers convert the differential signals to single ended.

The DTOS has two gain stages. The first one has constant gain of 12dB and 85kHz cut off frequency. The gain of second stage is controlled with control signal g10. If g10 is high (1) the gain is 6dB and if g10 is low (0) the gain of the stage is -4dB. The active channel filters in HAGAR provide selectivity for channels (-3dB @ ± 91 kHz typ.). The integrated baseband filter inside HAGAR is an active-RC-filter with two off-chip capacitors. Large RC-time constants are needed in the channel select filter of the direct-conversion receiver and are achieved with large off-chip capacitors because the impedance levels could not be increased due to the noise specifications.

The baseband filter consists of two stages, DTOS and BIQUAD. DTOS is differential to single-ended converter having 8dB or 18dB gain. BIQUAD is modified Sallen-Key Biquad. Integrated resistors and capacitors are tunable. These are controlled with a digital control word. The correct control words that compensate for the process variations of integrated resistors and capacitors and of tolerance of off chip capacitors are found with the calibration circuit.

The next stage in the receiver chain is AGC-amplifier, also integrated into HAGAR. AGC has digital gain control via serial mode bms. AGC-stage provides gain control range (40 dB, 10 dB steps) for the receiver and also the necessary DC compensation. Additional 10 dB AGC step is implemented in DTOS stages.

DC compensation is made during DCN1 and DCN2 operations ( controlled via serial bus ). DCN1 is carried out by charging the large external capacitors in AGC stages to a voltage which effect a zero dc-offset. DCN2 set the signal offset to constant value ( $V_{ref}$RF_02 1.35 V ). The $V_{ref}$RF_02 signal is used as a zero level to RX ADCs.

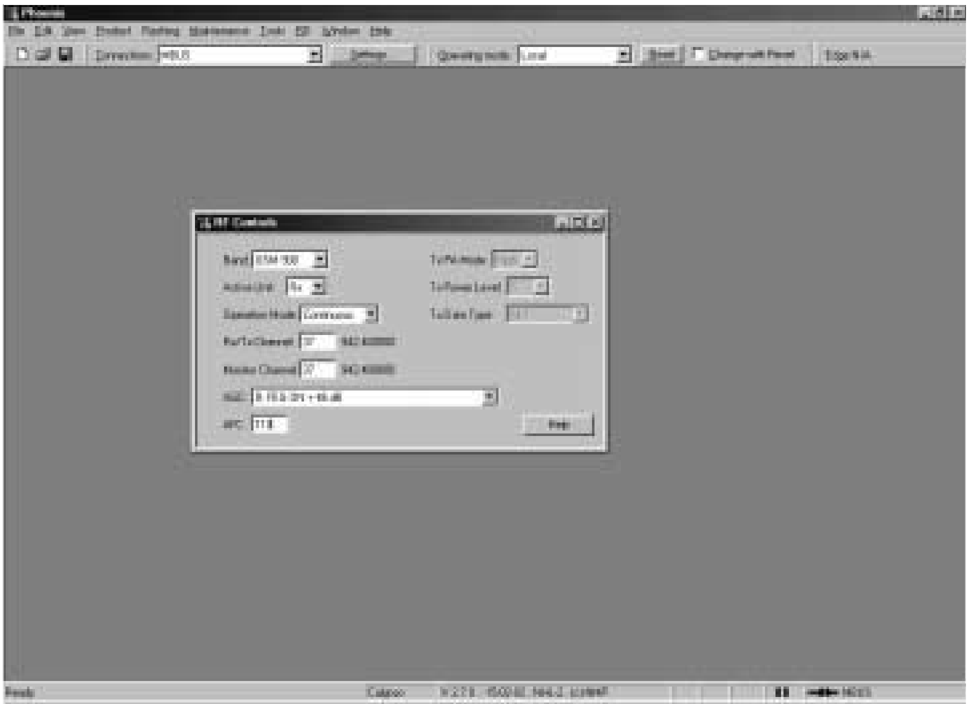
Single ended filtered I/Q-signal is then fed to ADCs in BB. Input level for ADC is 1.45 $V_{pp}$ max.

Rf-temp port is intended to be used for compensation of RX SAW filters thermal behavior. This phenomena will have impact to RSSI reporting accuracy. The current information is -35ppm/C for center frequency drift for all bands. This temperature information is a voltage over two diodes and diodes are fed with constant current.

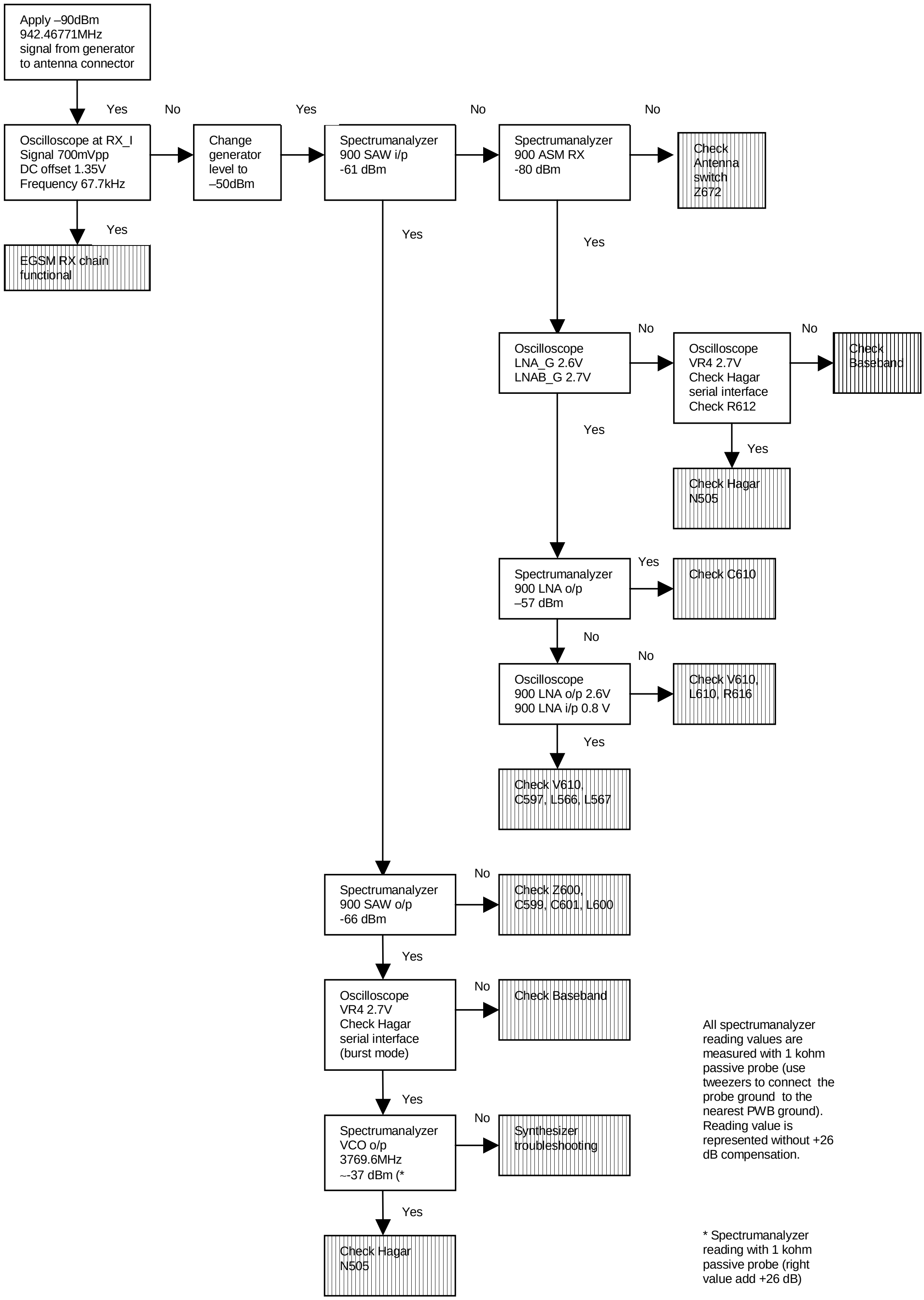
### E-GSM900

E-GSM900 RX Troubleshooting Setup steps

| | |
|---|---|
| 1 | Place the phone in the test jig |
| 2 | File → Choose Product → Calypso |
| 3 | From 'Toolbar' set operating mode to Local |
| 4 | Maintenance → Testing → RF Controls |
| 5 | Select band 'GSM900' |
| 6 | Set Active unit to 'Rx' |
| 7 | Set Operation mode to 'Continuous' |
| 8 | Set AGC to '8:FEG ON +46 dB' |
| 9 | Set Rx/Tx channel to 37 |



## Troubleshooting diagram for GSM900 receiver:



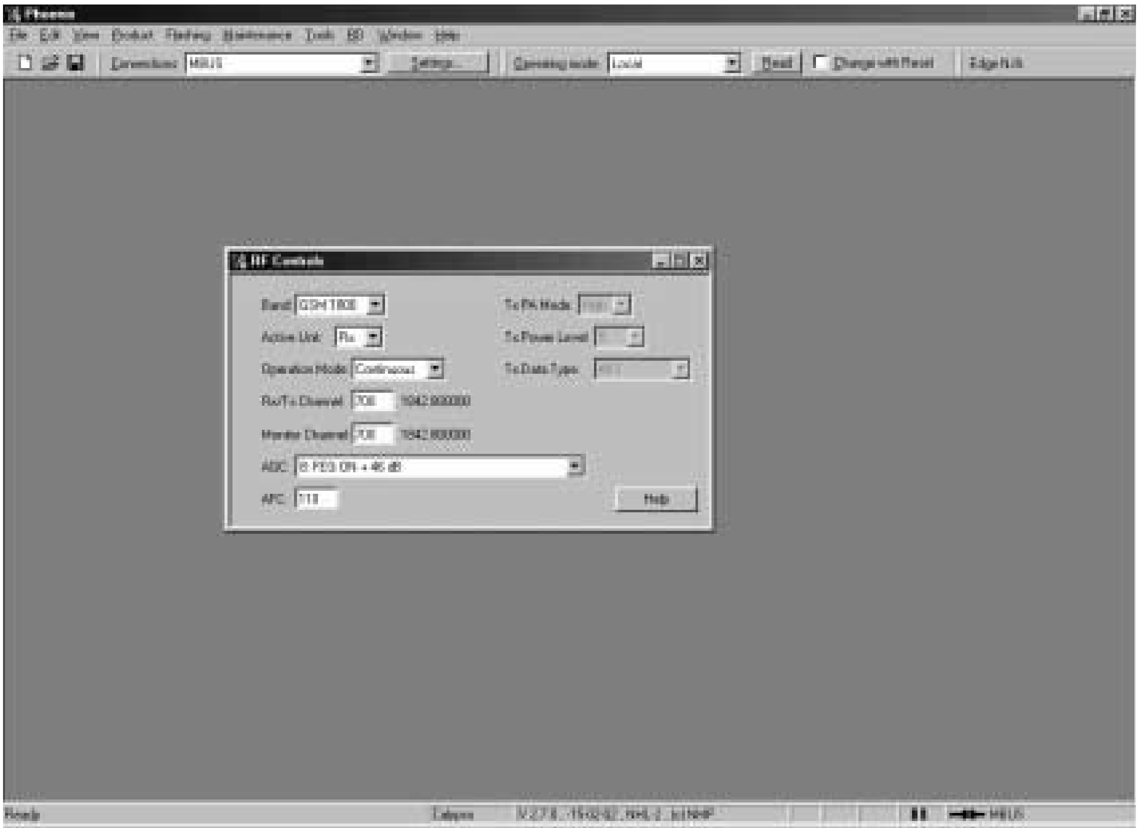

All spectrumanalyzer reading values are measured with 1 kohm passive probe (use tweezers to connect the probe ground to the nearest PWB ground). Reading value is represented without +26 dB compensation.

* Spectrumanalyzer reading with 1 kohm passive probe (right value add +26 dB)

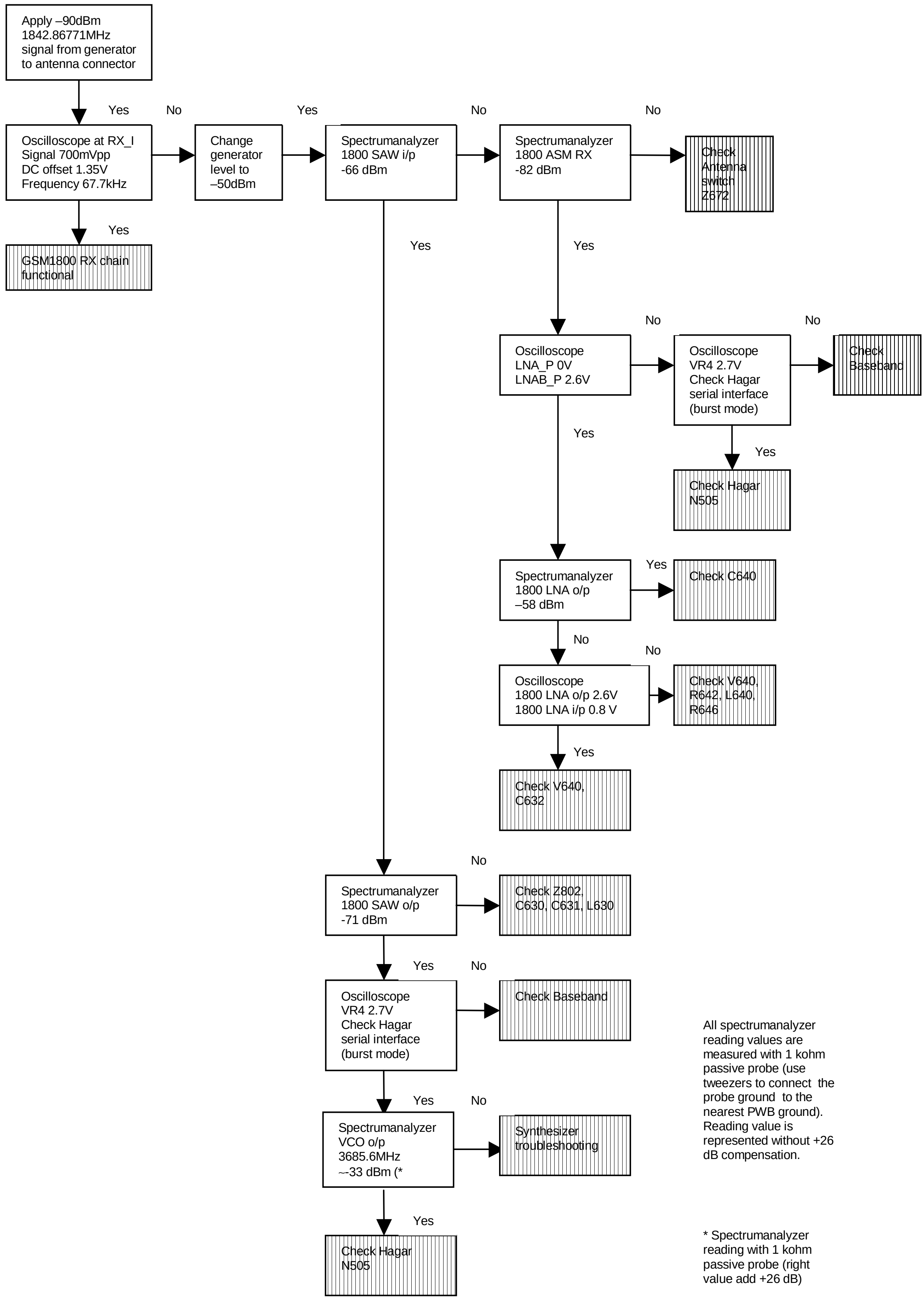
## GSM1800

GSM1800 RX Troubleshooting Setup steps:

| | |
|---|---|
| 1 | Place the phone in the test jig |
| 2 | File → Choose Product → Calypso |
| 3 | From 'Toolbar' set operating mode to Local |
| 4 | Maintenance → Testing → RF Controls |
| 5 | Select band 'PCN' |
| 6 | Set Active unit to 'Rx' |
| 7 | Set Operation mode to 'Continuous' |
| 8 | Set AGC to '8:FEG ON +46 dB' |
| 9 | Set Rx/Tx channel to 700 |



## Troubleshooting diagram for GSM1800 receiver

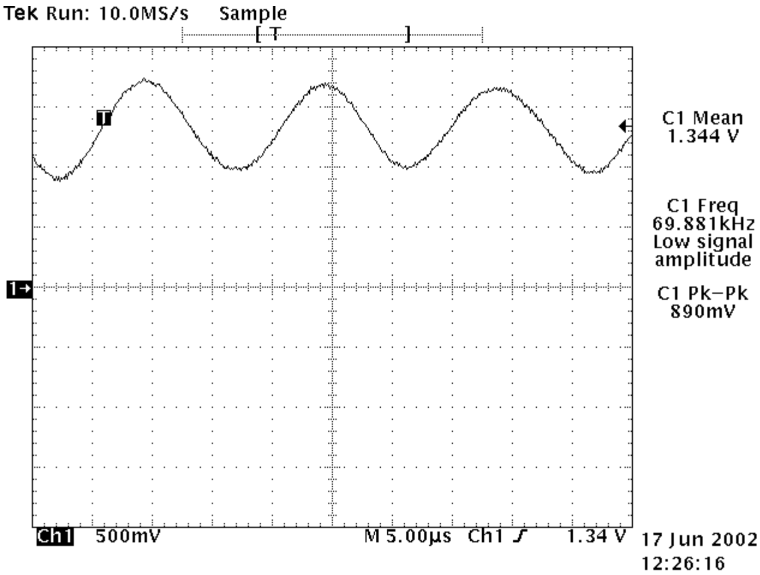



All spectrumanalyzer reading values are measured with 1 kohm passive probe (use tweezers to connect the probe ground to the nearest PWB ground). Reading value is represented without +26 dB compensation.

* Spectrumanalyzer reading with 1 kohm passive probe (right value add +26 dB)

## Picture of RX signal

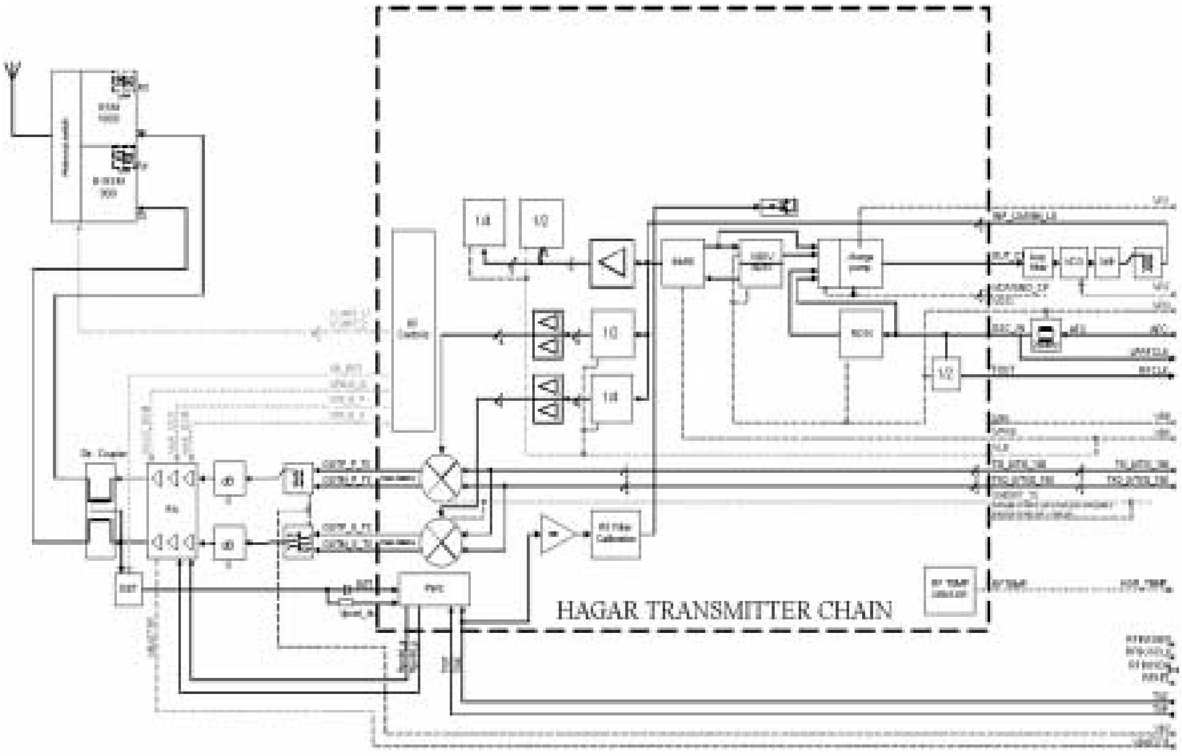
**Figure 1:** Example of RX_I (or RX_Q) signal at –90dBm signal level



# Transmitter

## General description




The transmitter chain consists of two final frequency I/Q-modulators, one for E-GSM900 and the other for the GSM1800 band, a dual power amplifier and a power control loop. The I- and Q-signals are generated by baseband. After post filtering ( RC network) they go into IQ-modulator in HAGAR. The LO signal for the modulator is generated by the external VCO and is divided by 2 or by 4 depending on the system mode. There are separate outputs one for E-GSM900 and one for GSM1800.

In the E-GSM900 branch, a SAW filter is placed before PA to attenuate unwanted signals and wide-band noise from the HAGAR IC.

The final amplification is realized with dual band power amplifier. It has two separate power chains one for E-GSM900 and one for GSM1800. The PA is capable of producing in excess of 2 W ( 0 dBm input level ) in the E-GSM900 band and over 1 W ( 0 dBm input level ) in the GSM1800 band assuming a 50 W output. The gain control range is over 45 dB to achieve the desired power levels and power ramp/decay performance.

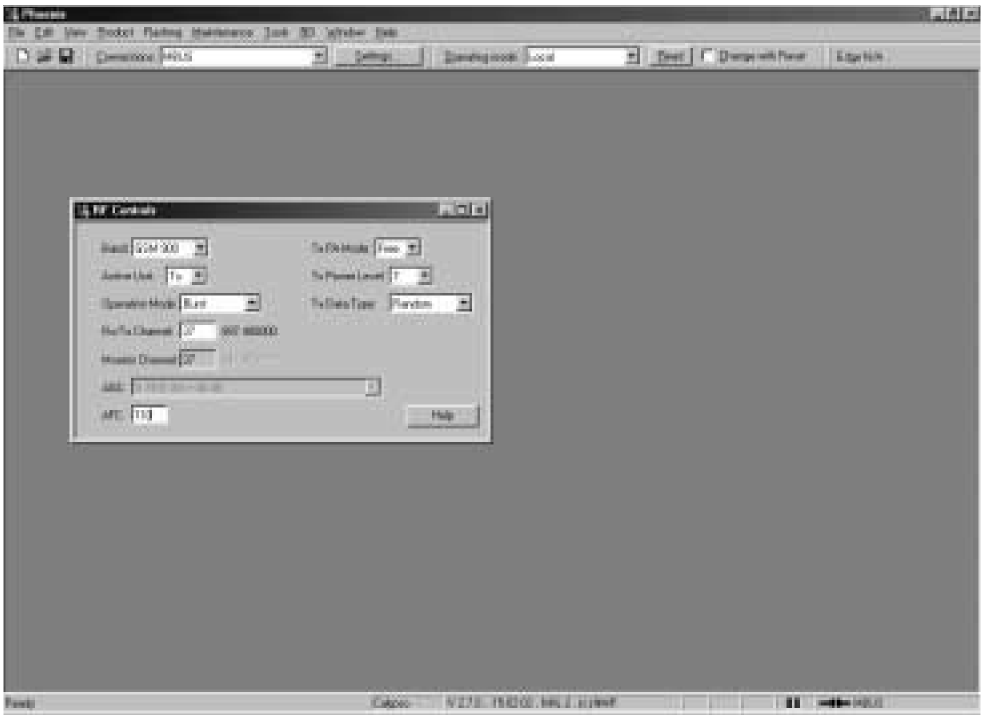
Harmonics generated by the nonlinear PA are filtered out with filtering inside the antenna switch -module.

Power control circuitry consists of discrete power detector ( common to E-GSM900 and GSM1800 bands ) and error amplifier internal to HAGAR. There is a directional coupler connected between PA output and antenna switch. It is a dual-band type and has input and outputs for both systems. Dir. coupler takes a sample from the forward going power with certain ratio. This signal is rectified using a Schottky-diode and produces a DC-signal after filtering.

## E-GSM900

**Figure 2: E-GSM900 TX Troubleshooting Setup steps**

| | |
|---|---|
| 1 | Place the phone in the test jig |
| 2 | File → Choose Product → Calypso |
| 3 | From 'Toolbar' set operating mode to Local |
| 4 | Maintenance → Testing → RF Controls |
| 5 | Select band 'GSM900' |
| 6 | Set Active unit to 'Tx' |
| 7 | Set Operation mode to 'Burst' |
| 8 | Set TX data type to 'Random' |
| 9 | Set Rx/Tx channel to 37 |
| 10 | Set Tx PA mode to 'Free' |
| 11 | Set power level to 5 |

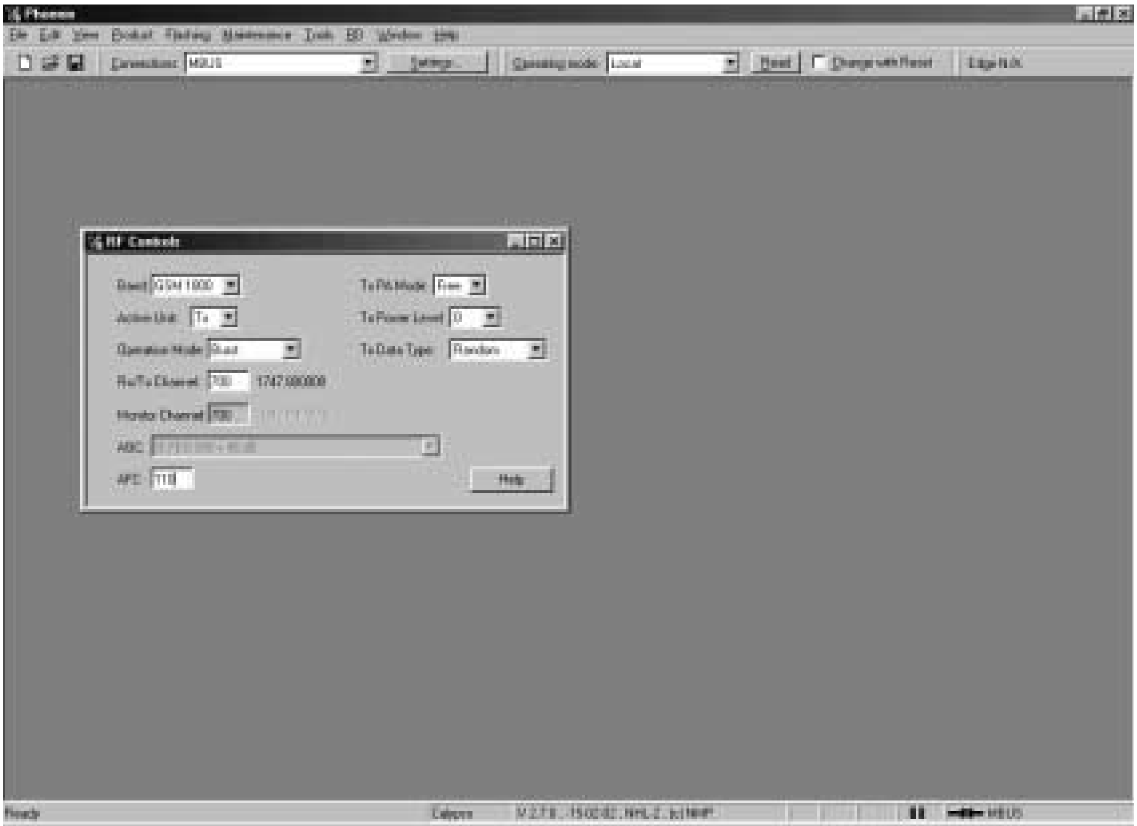


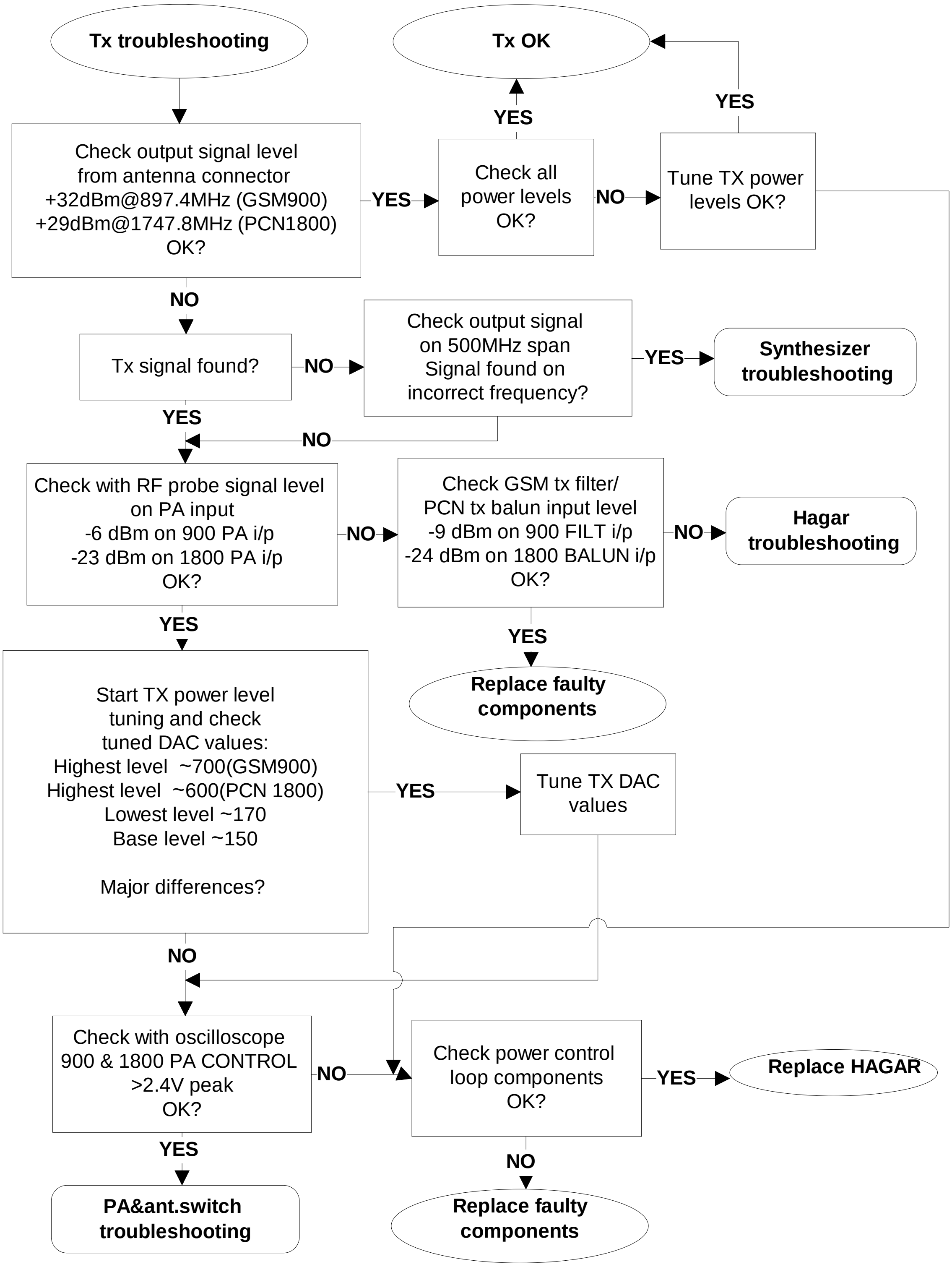
## GSM1800

**Figure 3: GSM 1800 TX Troubleshooting Setup steps**

| | |
|---|---|
| 1 | Place the phone in the test jig |
| 2 | File → Choose Product → Calypso |
| 3 | From 'Toolbar' set operating mode to Local |
| 4 | Maintenance → Testing → RF Controls |
| 5 | Select band 'PCN' |
| 6 | Set Active unit to 'Tx' |
| 7 | Set Operation mode to 'Burst' |
| 8 | Set TX data type to 'Random' |
| 9 | Set Rx/Tx channel to 700 |
| 10 | Set Tx PA mode to 'Free' |
| 11 | Set power level to 0 |



## Fault finding tree



## Example of TX signals

**Figure 4: Example of TXI signal**

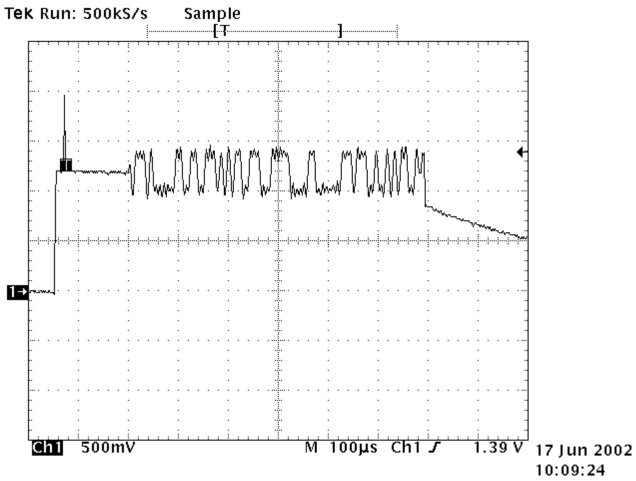



**Figure 5: Example of TXQ signal**

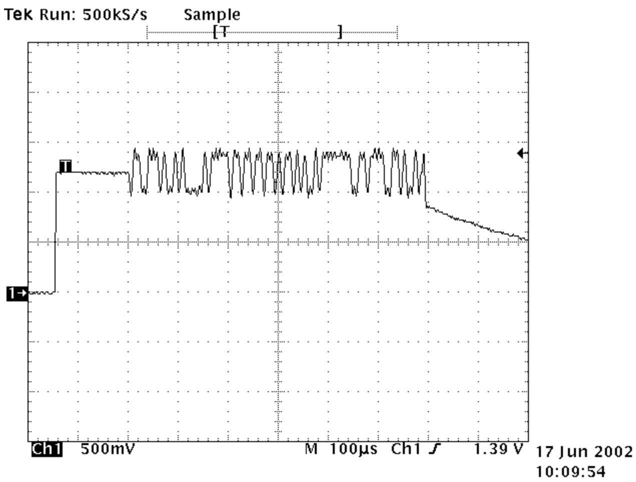



**Figure 6: Example of VC2 signal**

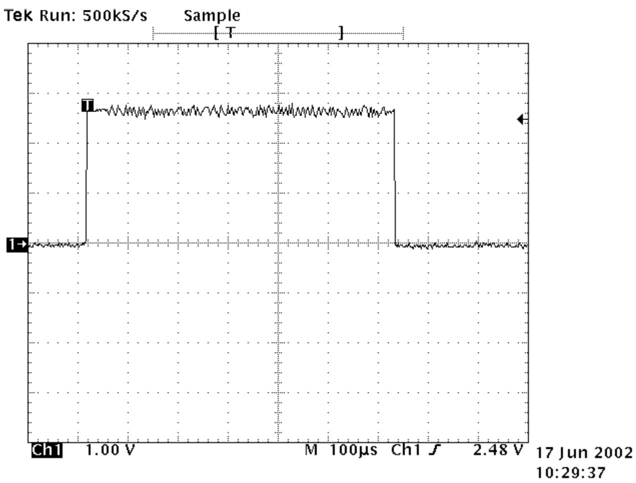


**Figure 7: Example of 900/1800 PA BIAS signal**

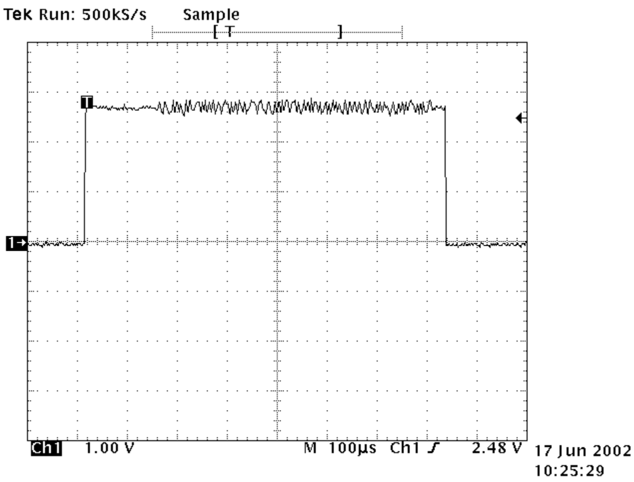



**Figure 8: Example of 900/1800 PA CONTROL signal**

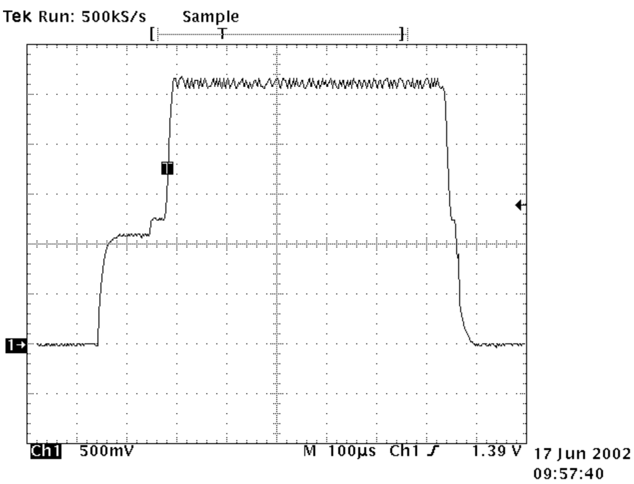
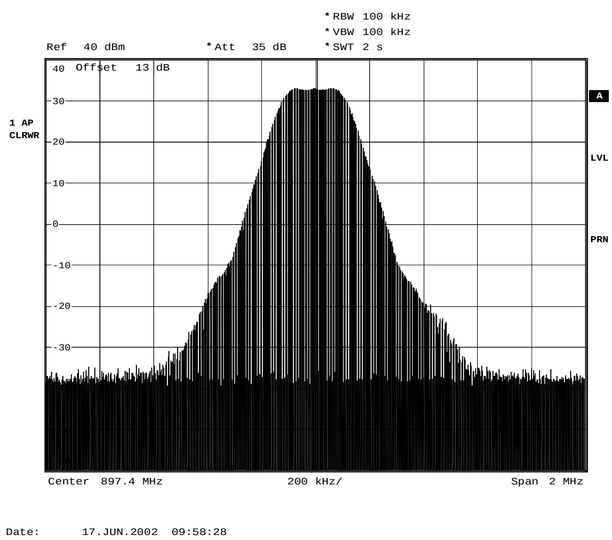



**Figure 9: Example of 900 TX burst from antenna connector**



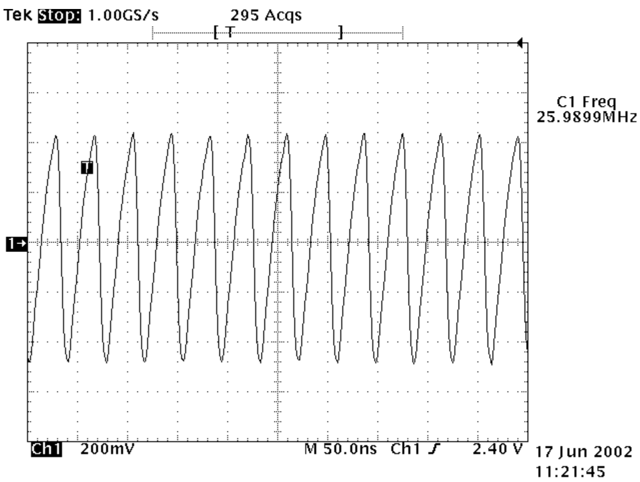
## Common

### Antenna switch control logic (reference Z672)

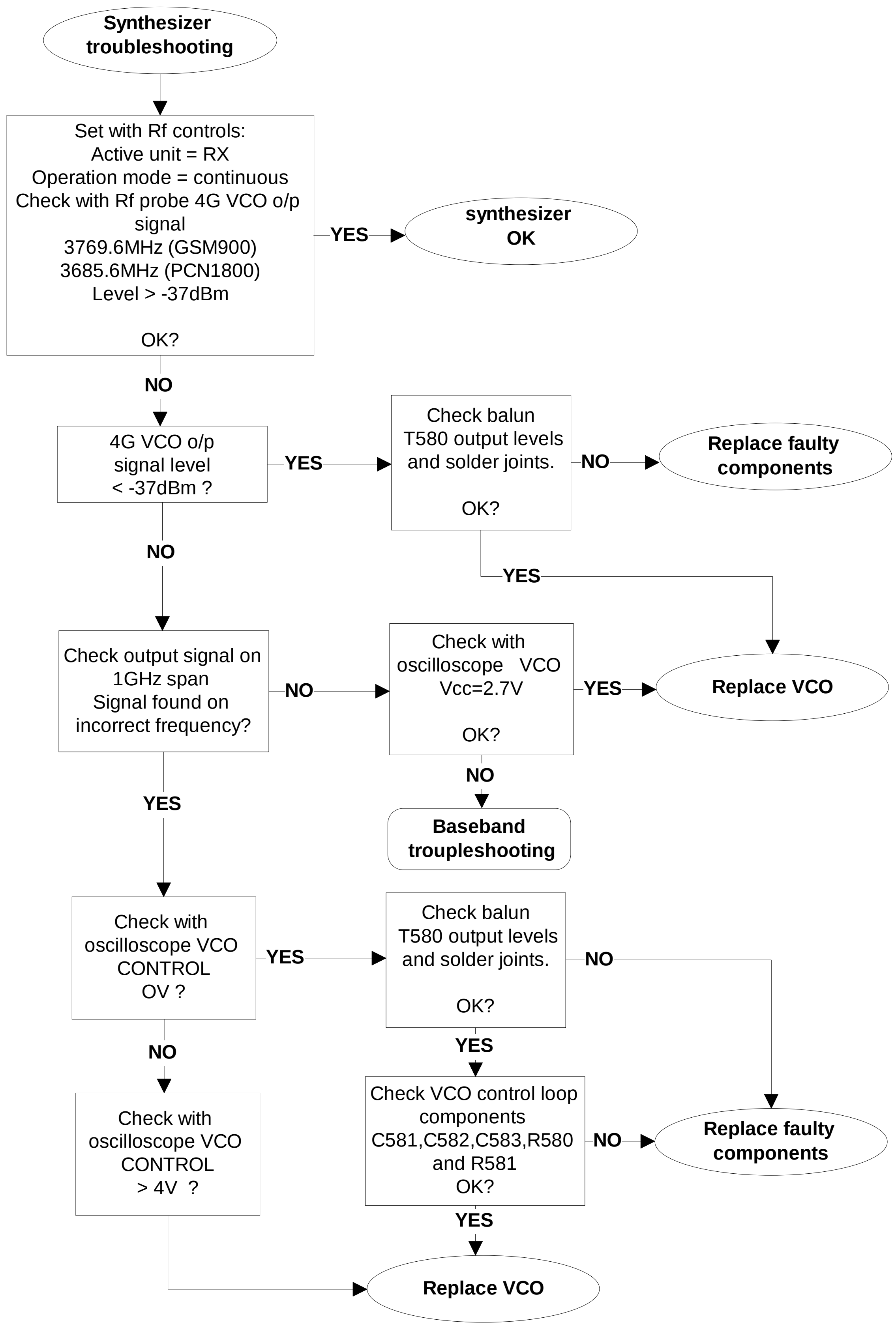
| | VC1 | VC2 |
|---|---|---|
| 900 TX | LOW | HIGH |
| 1800 TX | HIGH | LOW |
| RX | LOW | LOW |

### VCTCXO (reference G591)

Figure 10: Example of VCTCXO o/p signal



## Frequency synthesizer



## Example of synthesizer signal

**Figure 11: Example of 4G VCO o/p signal**

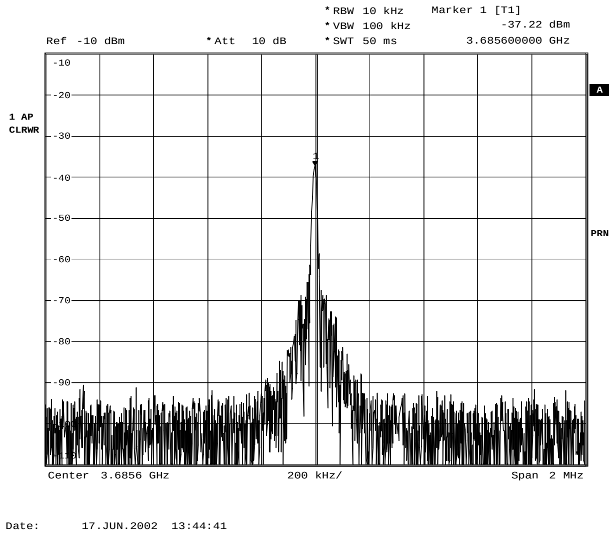



**Figure 12: Example of 4G VCO CONTROL signal, 900 RX, channel 124, continuous mode**

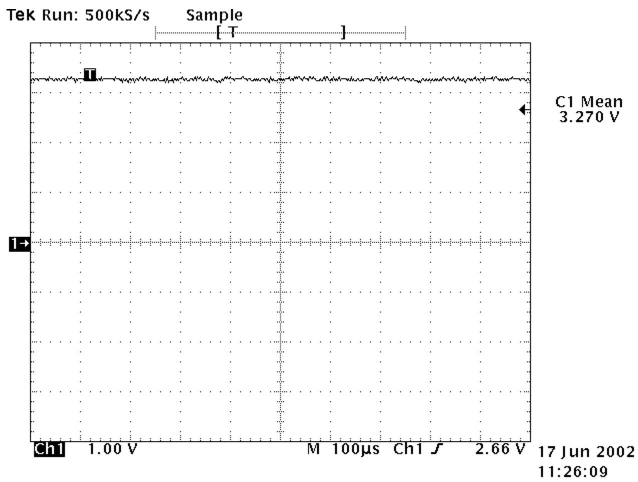
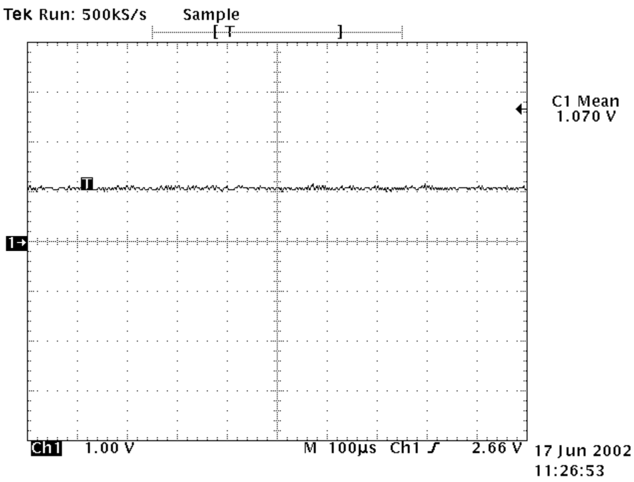
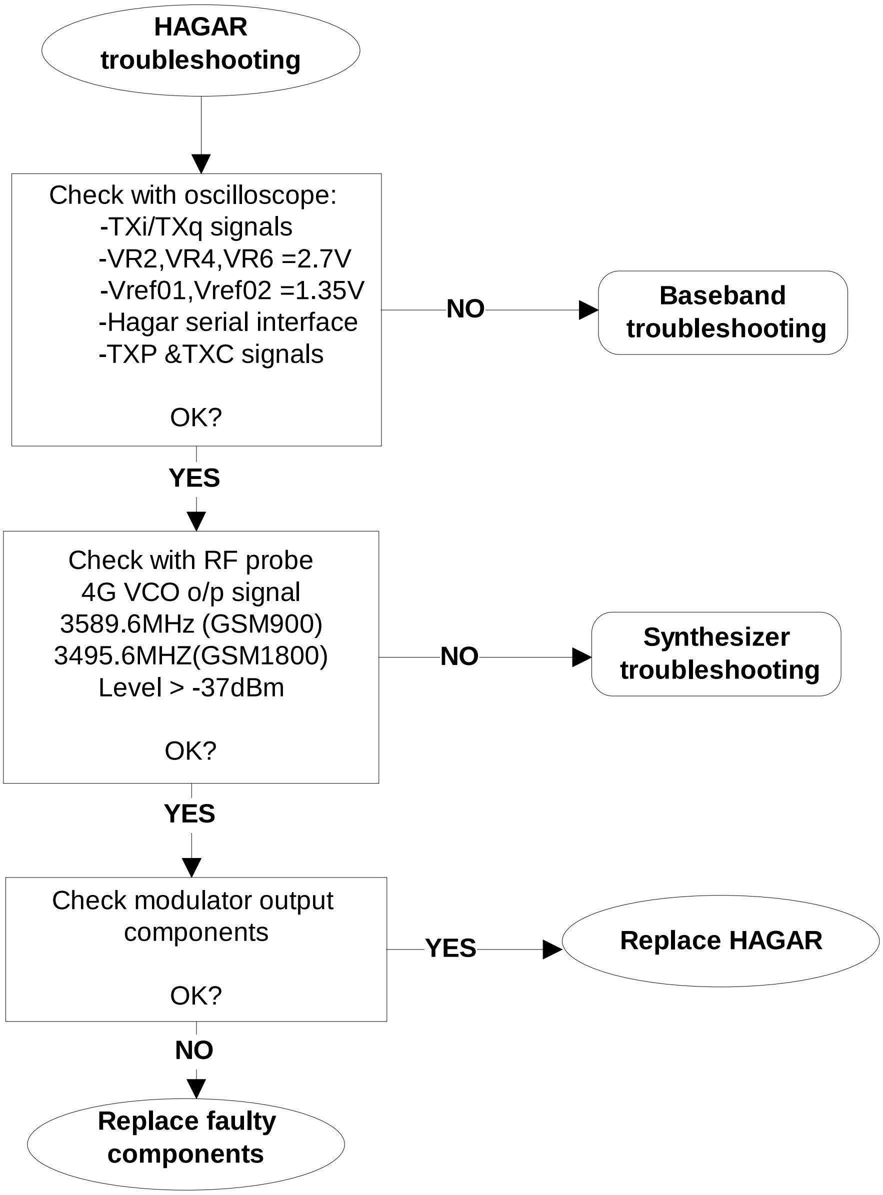


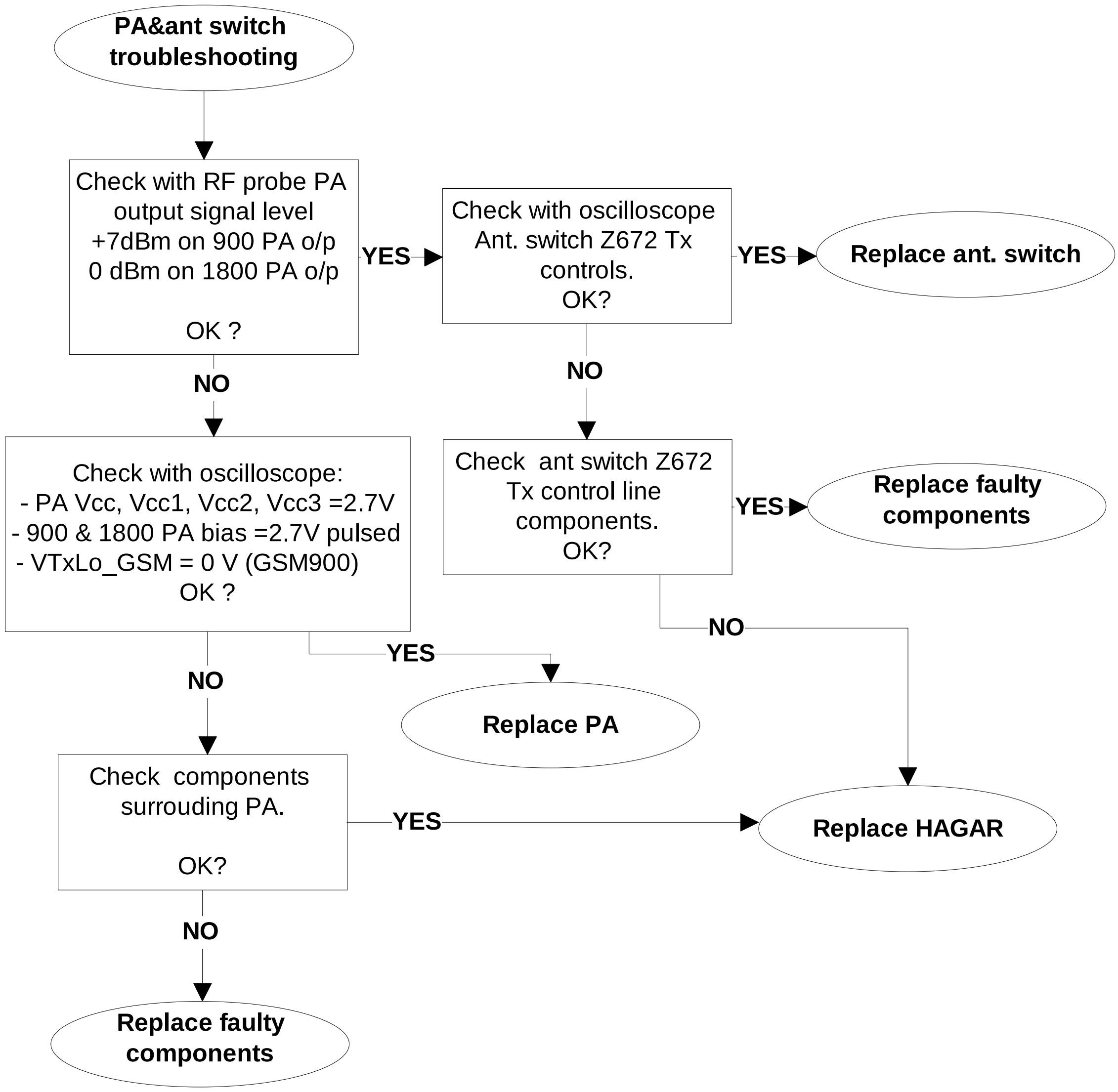
**Figure 13: Example of 4G VCO CONTROL signal, 1800 TX, channel 512, continuous mode**



## HAGAR


HAGAR troubleshooting
Check with oscilloscope:
-TXi/TXq signals
-VR2,VR4,VR6 =2.7V
-Vref01,Vref02 =1.35V
-Hagar serial interface
-TXP &TXC signals
OK?
NO
Baseband troubleshooting
YES
Check with RF probe
4G VCO o/p signal
3589.6MHz (GSM900)
3495.6MHZ(GSM1800)
Level > -37dBm
OK?
NO
Synthesizer troubleshooting
YES
Check modulator output components
OK?
YES
Replace HAGAR
NO
Replace faulty components

## PA and Antenna switch

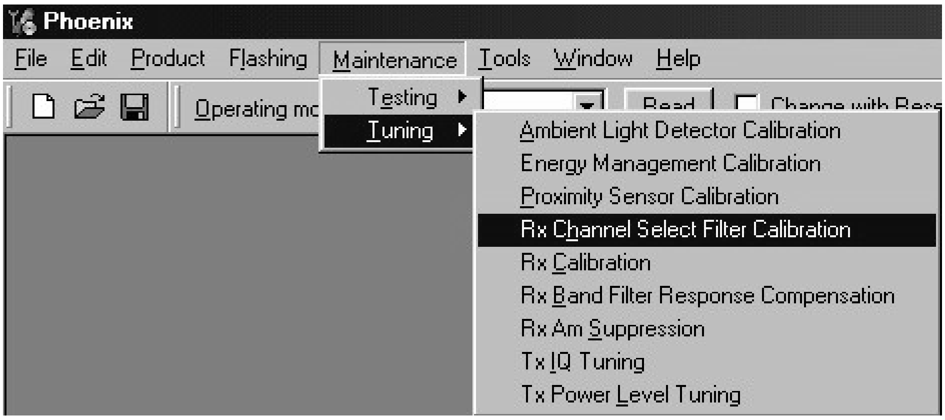


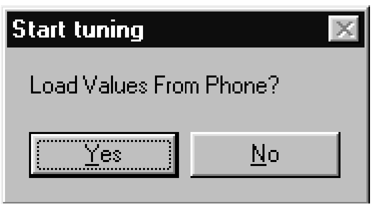
## Receiver tunings

### RX Channel Select Filter Calibration

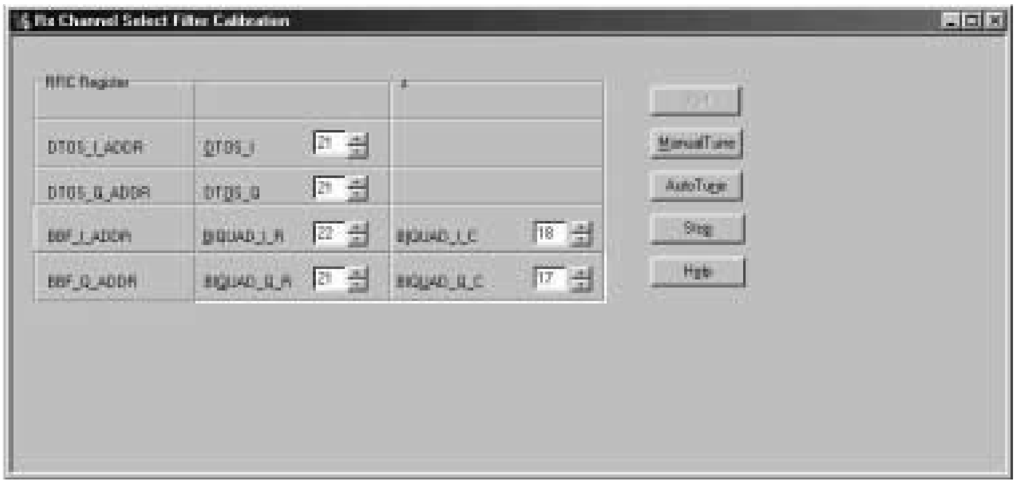
- Extra equipment / external RF signal not needed
- Must be done before other RX calibrations
- This function is used to calibrate RX channel select filter in GSM Phones.
- Rx Channel select filter is tuned only in one band = Single calibration for both bands
- Select Maintenance => Tuning => Rx Channel select filter calibration



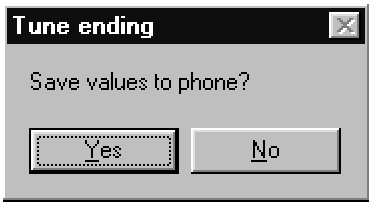

- Select “Yes” to start tuning with values already saved to the phone




- Press "AutoTune" to start the tuning



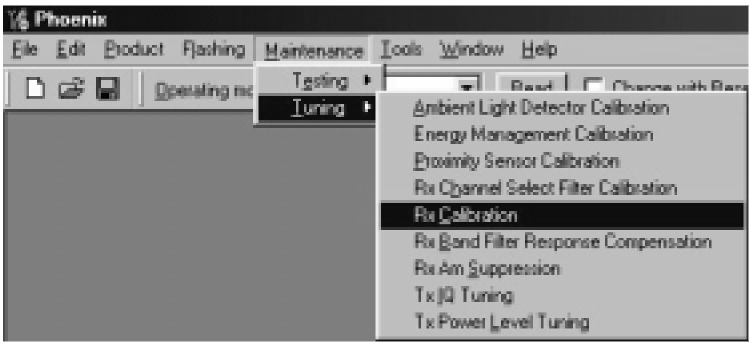

- Tuning values should be 0...31
- Select “Stop”
- If values shown are within limits, choose “Yes” to save values to the phone save them to phone.




- Close the “RX Channel Select Filter Calibration “– dialog to end tuning

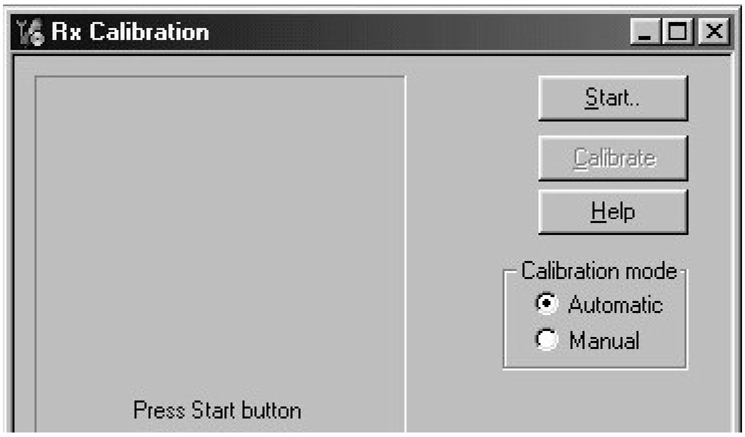
**RX Calibration**

- RF generator needed
- This tuning performs RX Calibration
- Must be done separately on both bands!
- Start RX Calibration at EGSM (GSM900), then do RX Calibration at GSM1800 band.
- AFC tuning is done while EGSM (GSM900) band RX Calibration is performed.
- *Remember to take jig and cable attenuations into account!*
- Select Maintenance => Tuning => Rx calibration

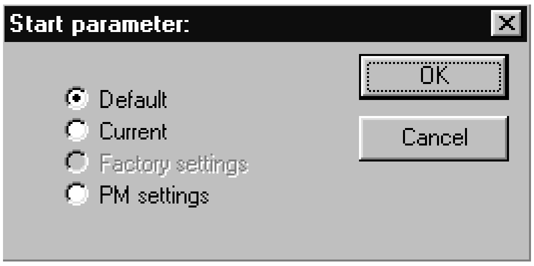



- When RX Calibration has been started, you can choose the correct band from the dropdown menu. Begin tuning from EGSM 900 band.

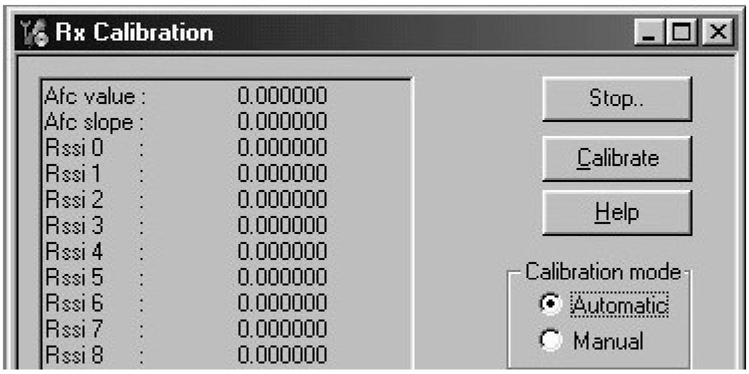

- Press "Start"



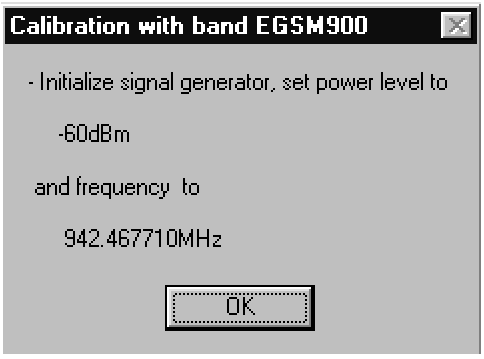

- Select “Default” to start tuning from factory default values => OK




- Set the Calibration mode to “Automatic”
- Press "Calibrate"




- Set RF generator to required frequency => OK

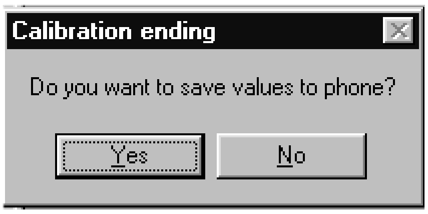



Tuning values and ADC readings will be shown

Typical values and limits in (GSM900) RX Calibration:

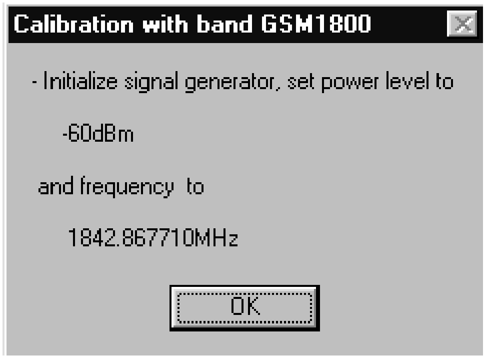
| **EGSM (GSM900)** | **Typical value** | **Limits** |
|---|---|---|
| AFC value | -176 | -350...+350 |
| AFC slope | 269 | 150...350 |
| RSSI0 | 74 | 67...77 |
| RSSI1 | 84 | 77...87 |
| RSSI2 | 94 | 87...97 |
| RSSI3 | 99.5 | 94...104 |
| RSSI4 | 109.5 | 104...114 |
| RSSI5 | 119.5 | 114...124 |
| RSSI6 | 129.5 | 124...134 |
| RSSI7 | 139.5 | 134...144 |
| RSSI8 | 149.5 | 144...152 |

- Choose “Stop” to end tuning
- If values shown are within limits, choose “Yes” to save values to the phone




- Continue tuning from GSM1800. Choose the correct band from the dropdown menu.
- Press "Start" to continue just like in the EGSM900 Band above.

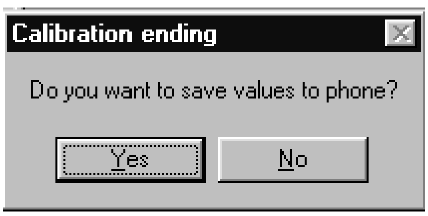

When asked, set RF generator to required frequency => OK




Typical values and limits in (GSM1800) RX Calibration:

| **GSM1800** | **Typical value** | **Limits** |
|---|---|---|
| RSSI0 | 66.5 | 63...73 |
| RSSI1 | 76.5 | 73...83 |
| RSSI2 | 86.5 | 83...93 |
| RSSI3 | 99.5 | 94...104 |
| RSSI4 | 109.5 | 104...114 |
| RSSI5 | 119.5 | 114...124 |
| RSSI6 | 129.5 | 124...134 |
| RSSI7 | 139.5 | 134...144 |
| RSSI8 | 149.5 | 144...152.5 |

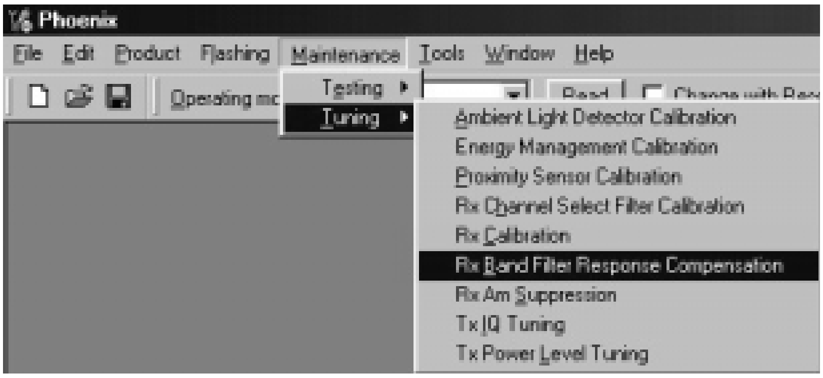
- Choose “Stop” to end tuning
- If values shown are within limits, choose “Yes” to save values to the phone



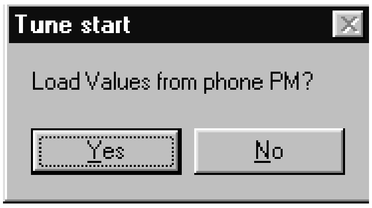
- Close the “RX – Calibration – dialog to end tuning

**RX Band Filter Response Compensation**

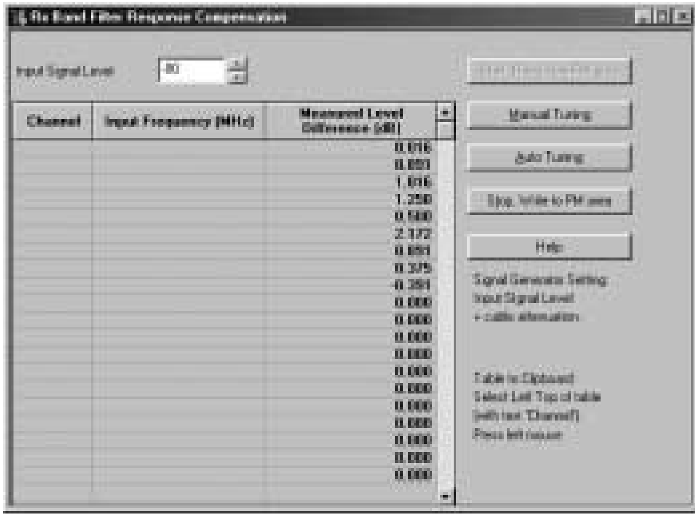
- RF generator needed
- Must be done separately on both bands!
- Start RX Band Filter Response Compensation at EGSM (GSM900), then do RX Band Filter Response Compensation at GSM1800 band.
- *Note: Remember to do RX calibration before doing Rx Band Filter Response Compensation!*
- Remember to take jig and cable attenuations into account!
- Select Maintenance => Tuning => Rx band filter response compensation



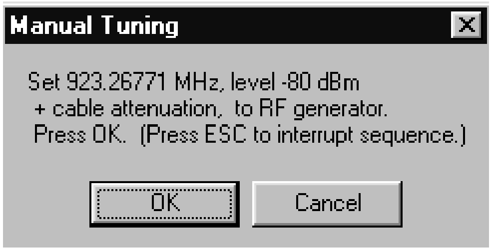

- Select “Yes” to start tuning with values already saved to the phone



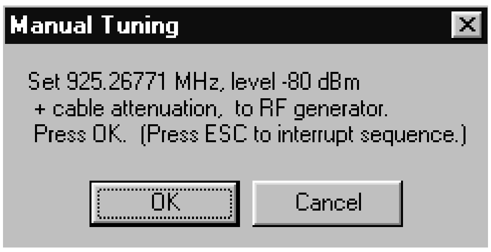

- Select "Manual tuning"



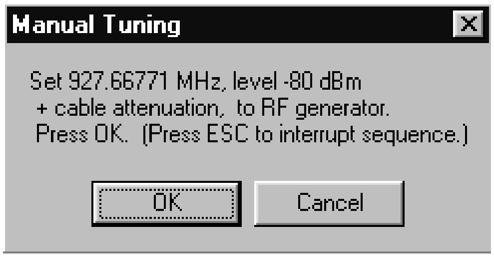

- You will be asked to supply 9 different RF frequencies to the phone
- Set first required frequency and level => OK



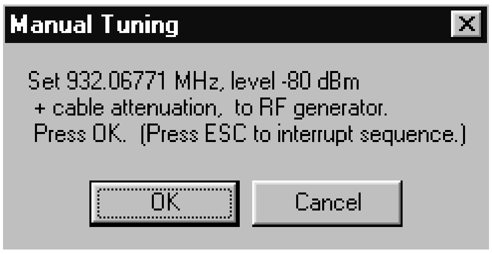

- Set 2nd required frequency and level => OK



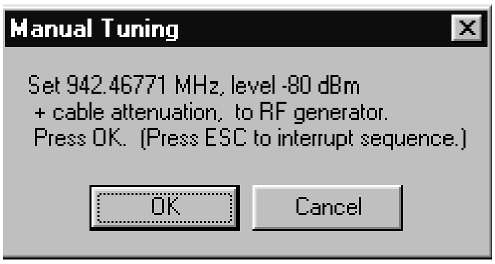

- Set 3rd required frequency and level => OK



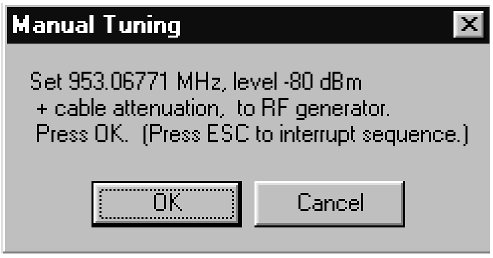

- Set 4th required frequency and level => OK



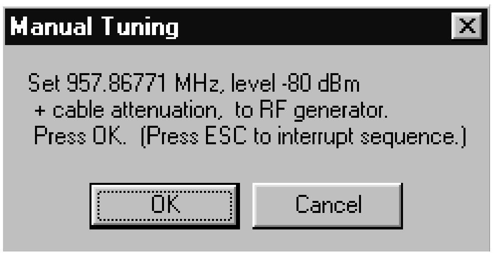

- Set 5th required frequency and level => OK



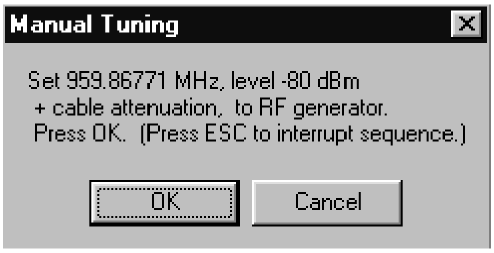

- Set 6th required frequency and level => OK



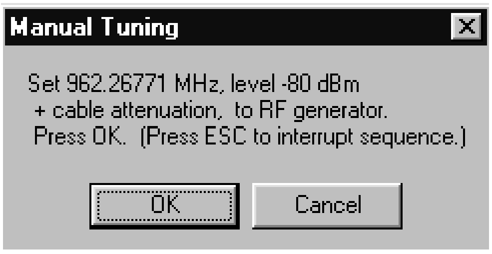

Set 7th required frequency and level => OK




Set 8th required frequency and level => OK




Set 9th required frequency and level => OK

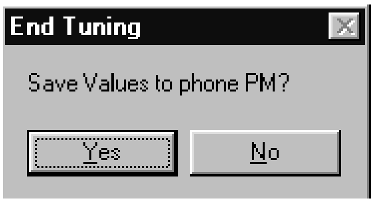



Typical values and limits in Rx Band Filter Response Compensation EGSM900:

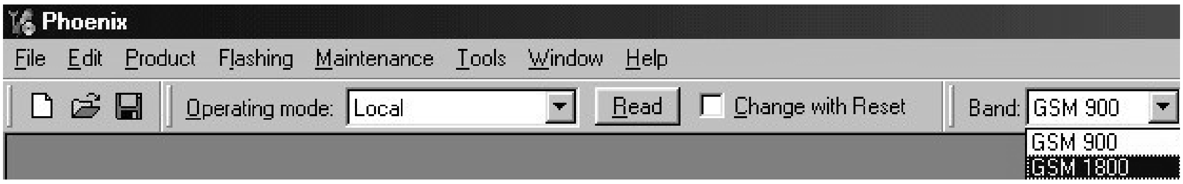
| **Channel** | **Input frequency (MHz)** | **Measured level difference (dB)** | **Limits (dB)** |
|---|---|---|---|
| 965 | 923.26771 | -0.118 | -10...+5 |
| 975 | 925.26771 | 0.511 | -5...+5 |
| 987 | 927.66771 | 0.857 | -5...+5 |
| 1009 | 932.06771 | 1.174 | -5...+5 |
| 37 | 942.46771 | 0.569 | -5...+5 |
| 90 | 953.06771 | 1.928 | -5...+5 |
| 114 | 957.86771 | 0.964 | 5...+5 |
| 124 | 959.86771 | 0.545 | -5...+5 |
| 136 | 962.26771 | -0.040 | -10...+5 |

- Choose "Stop, write to PM area"

- If values shown are within limits, choose “Yes” to save values to the phone




**Continue tuning from GSM1800.** Choose the correct band from the dropdown menu.




- Repeat the same steps as for the EGSM900 band above

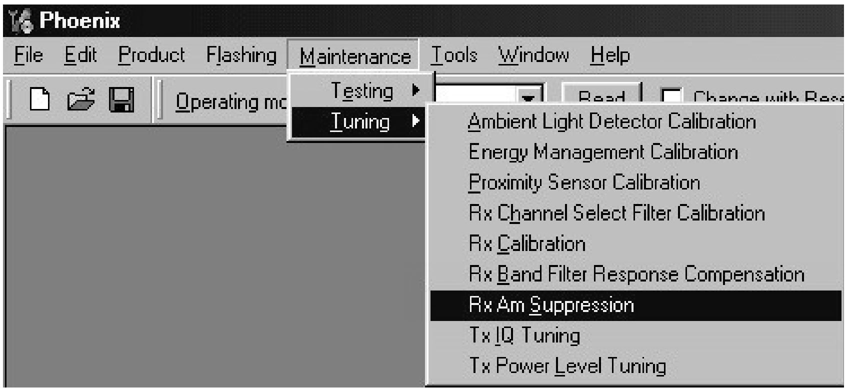
Typical values and limits in Rx Band Filter Response Compensation GSM1800:

| Channel | Input frequency (MHz) | Measured level difference (dB) | Limits (dB) |
|---|---|---|---|
| 497 | 1802.26771 | 0.214 | -10...+5 |
| 512 | 1805.26771 | 1.739 | -5...+5 |
| 535 | 1809.86771 | 2.056 | -5...+5 |
| 606 | 1824.06771 | 1.632 | -5...+5 |
| 700 | 1842.86771 | 0.583 | -5...+5 |
| 791 | 1861.06771 | 0.734 | -5...+5 |
| 870 | 1876.86771 | 0.616 | -5...+5 |
| 885 | 1879.86771 | 0.185 | -5...+5 |
| 908 | 1884.46771 | -1.132 | -10...+5 |

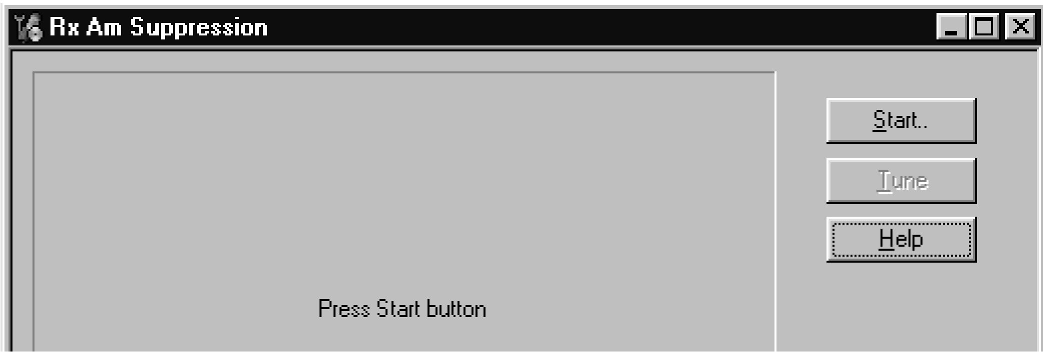
- If values shown are within limits, save values to the phone
- Close the “RX Band Filter Response Compensation” – dialog to end tuning

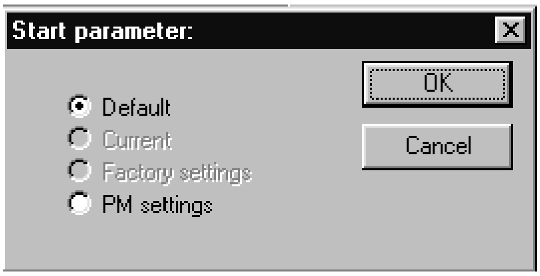
**RX AM Suppression**

- RF generator needed (AM modulation)
- Must be done separately on both bands!
- Start RX AM Suppression at EGSM (GSM900), then do RX AM Suppression at GSM1800 band.
- This dialog performs RX AM Suppression.
- Remember to take jig and cable attenuations into account!
- Select Maintenance => Tuning => Rx Am suppression

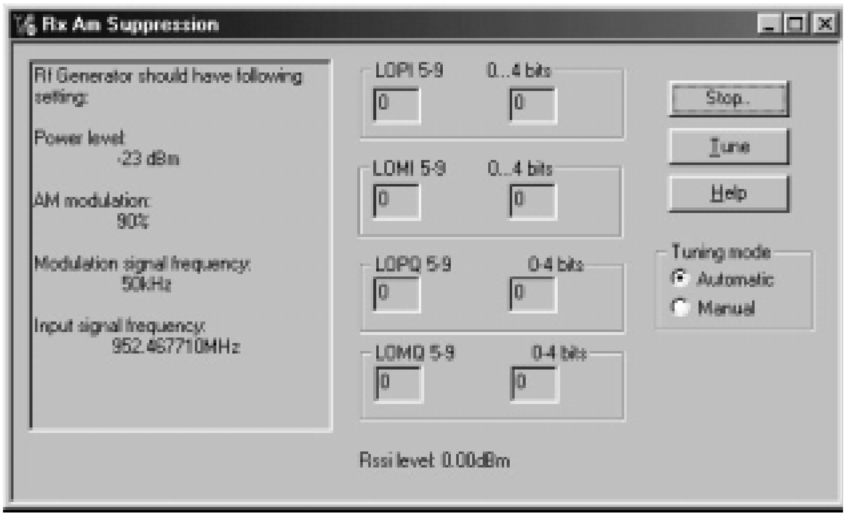



- Start => Default settings => OK,

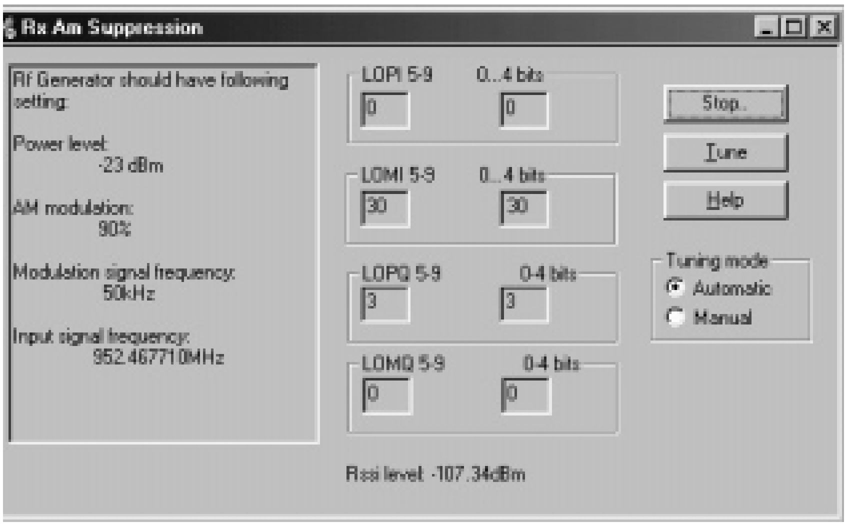




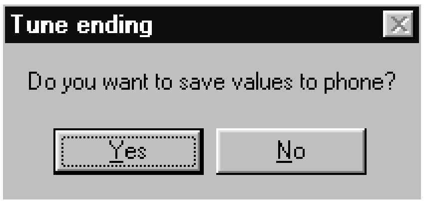

- Set RF generator to state described in left-side window.
- Set the Tuning mode to “Automatic”
- Press the “Tune” button to perform actual tuning.
- The new tuning values and Rssi dBm value are updated.




- One "I" and "Q" line values sold be 0, other values 0..31
- RSSI level should be around -107 dBm




- If values shown are within limits, Select “Stop”
- Choose “Yes” to save values to the phone



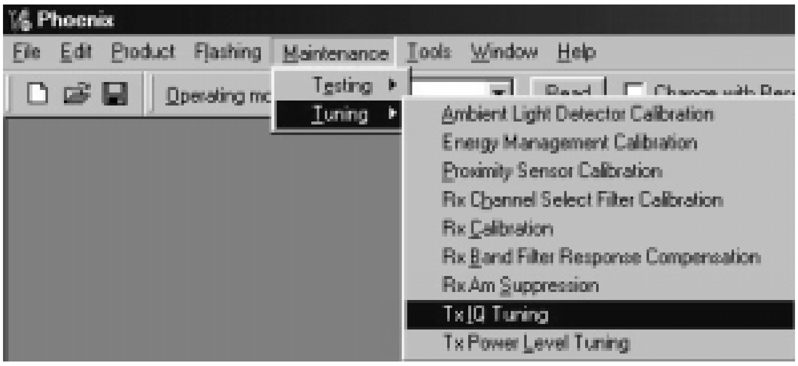

- **Continue tuning from GSM1800.** Choose the correct band from the dropdown menu.


- Repeat the same steps as for the EGSM900 band
- If values shown are within limits, choose “Yes” to save values to the phone
- Close the “RX AM Suppression” – dialog to end tuning

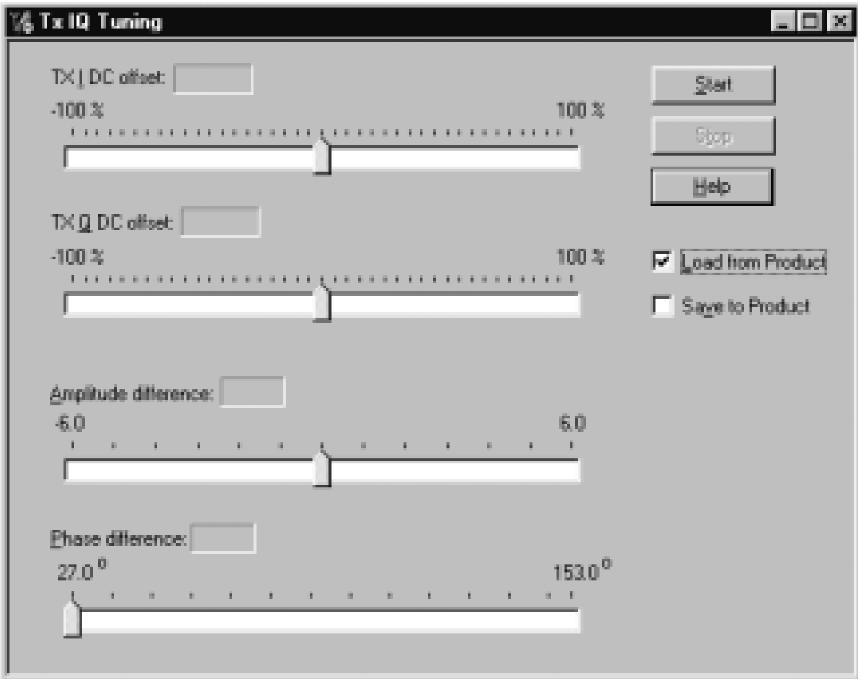
## Transmitter Tunings

### TX I/Q Tuning

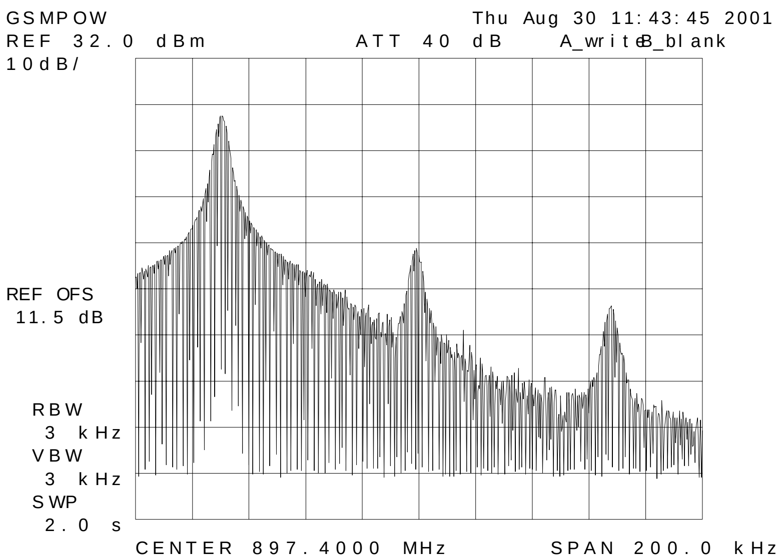
- Spectrum analyzer needed
- Tx IQ Tuning allows changing the Tx I DC Offset, Tx Q DC Offset, Amplitude difference and Phase difference
- Must be done separately on both bands!
- Start TX I/Q Tuning at EGSM (GSM900), then continue at GSM1800 band.
- Remember to take jig and cable attenuations into account!
- Select Maintenance => Tuning => Tx_IQTuning




- Select "Load from product" => Start
- The tuning is done by setting each of the sliders to desired value. The sliders can be changed only when the tuning is ongoing.
- The order of tuning should be same as the order of the sliders e.g. the Tx I DC Offset is tuned first and Phase difference is tuned last.
- Use <=, =>, PgUp or PgDn keys



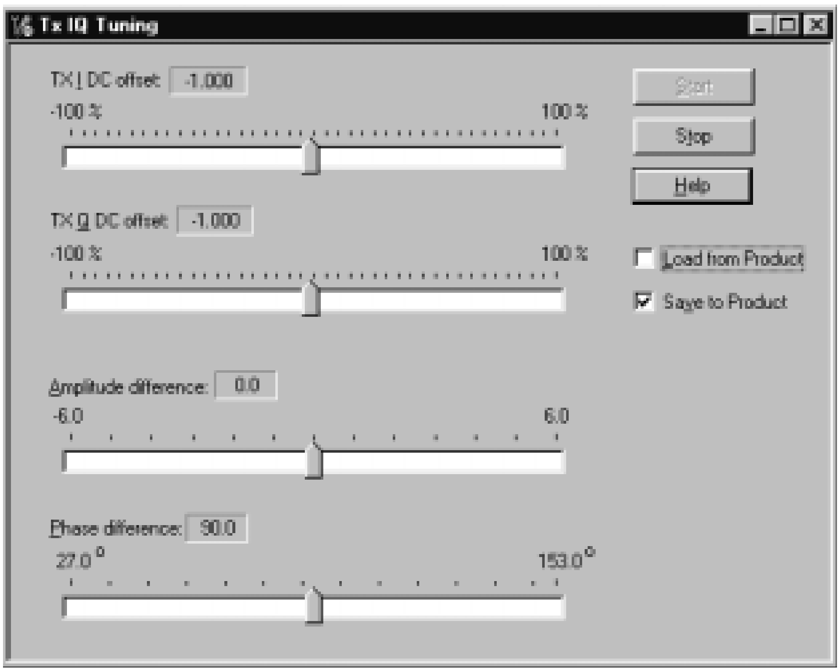

- Set spectrum analyzer center frequency to 897.4 MHz, span 200kHZ, RBW and VWB 3kHz and sweeptime to 2 seconds
- Tune LO leak to minimum with TXI/TXQ DC offset control (**f0 on spectrum analyzer screen**)
- Tune wrong sideband to minimum using Amplitude/Phase difference controls (**f0+68kHz on spectrum analyzer screen**)



**Typical TX Iq Tuning Values and tuning limits GSM 900:**

| | | |
|---|---|---|
| I DC Offset | -2.5...+0.5 | -6...+6 |
| Q DC Offset | -2.5...+0.5 | -6...+6 |
| Amplitude difference | -0.2...+0.2 | -1...+1 |
| Phase difference | 88.0°....92.0° | 80°...100° |

- If values shown are within limits, check the "Save to product" tick box and choose “Stop” save the new values to the product




- **Continue tuning from GSM1800.** Choose the correct band from the dropdown menu.


- Repeat the same steps as for the EGSM900 band
- Set spectrum analyzer center frequency to 1747.8 MHz, span 200kHZ, RBW and VWB 3kHz and sweeptime to 2 seconds

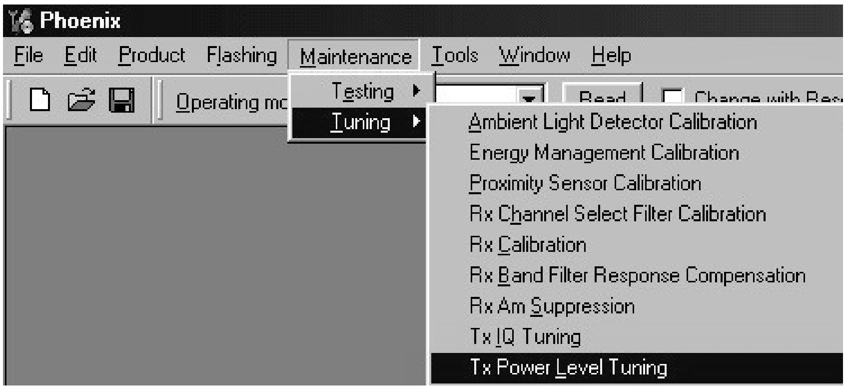
**Typical TX IQ Tuning Values and tuning limits GSM1800:**

| | | |
|---|---|---|
| I DC Offset | -3.0...0.0 | -6...+6 |
| Q DC Offset | -1.5...+1.0 | -6...+6 |
| Amplitude difference | -0.5...+0.0 | -1...+1 |
| Phase difference | 90.0°...97.0° | 80°...100° |

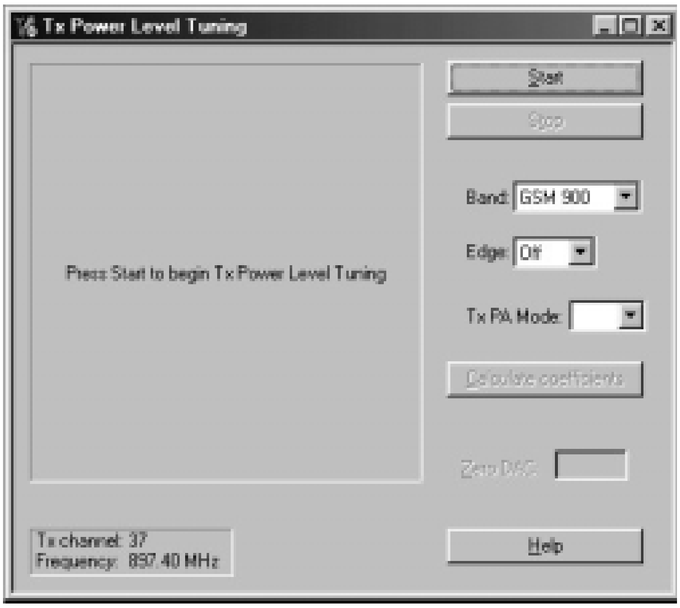
- If values shown are within limits, check the "Save to product" tick box and choose "Stop" save the new values to the product
- Close the "TX I/Q Tuning" – dialog to end tuning

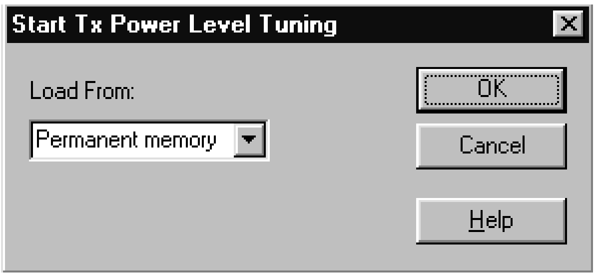
### TX Power Level Tuning

- Power Meter with peak power sensor (or Spectrum analyzer) needed
- With Tx Power Level Tuning, the coefficients are adjusted for each power level
- Must be done separately on both bands!
- Start Power Level tuning at EGSM (GSM900), then continue at GSM1800 band.
- In EGSM900 band The power level tuning is made for both high and low PA Modes
- In GSM1800 band only for high PA mode.
- Maintenance => Tuning => Tx power level tuning
- Remember to take jig and cable attenuations into account!

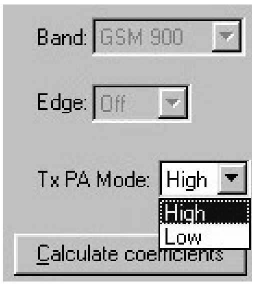



- Select “Start” => “Load from: Permanent memory” => “OK “
- *Note that TX PA mode is “High” at this point.*




- The coefficient table lists the power level, coefficient, target dBm and DAC value for each power level.
- The tuned power level can be chosen by using up and down arrows or mouse.
- The current power level is shown with inverse colors.
- The tuning value can be adjusted with “-“ and “+” keys
- **Tune base level and power levels 19,15 and 5** to target level
- Press "Calculate coefficients"
- **Change TxPA Mode to “Low**“ from the drop down menu. When the PA Mode is changed, the previous values are saved in memory and the ones for new mode are shown

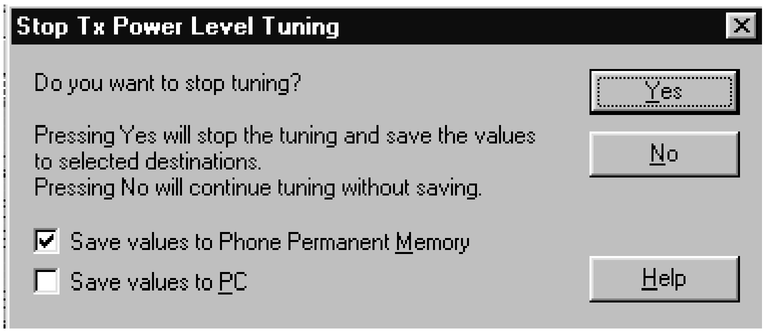



- **Tune power levels __19__, __15__ and __7__** (Levels 5 & 6 are not used, base level tuning not needed)
- Press "Calculate coefficients"

Typical values: EGSM900

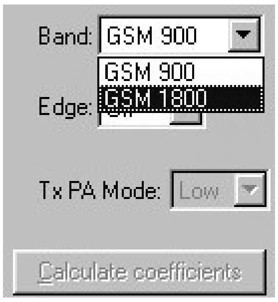
| Power level | PA high mode | PA low mode |
|---|---|---|
| 5 | 0.700...0.750 | - |
| 7 | - | 0.530...0.570 |
| 15 | 0.190...0.210 | 0.190...0.210 |
| 19 | 0.170...0.180 | 0.170...0.180 |
| Base | 0.140...0.150 | 0.140...0.150 |

- If values shown are within limits select “Stop” and check “Save values to phone permanent memory”
- Select “Yes” to save values to phone

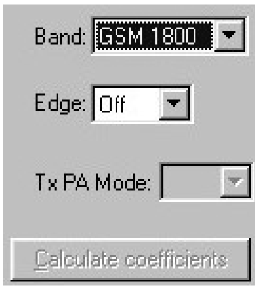



- **Continue tuning from GSM1800.** Choose the correct band from the dropdown menu.




- Repeat the same steps as for the EGSM900 band above
- Note that In GSM1800 band PA mode can not be changed because tuning is only made in “High” mode




Typical values: GSM1800

| Power level | PA high mode |
|---|---|
| 0 | 0.620...0.670 |
| 11 | 0.170...0.190 |
| 15 | 0.150...0.170 |
| Base | 0.140...0.150 |

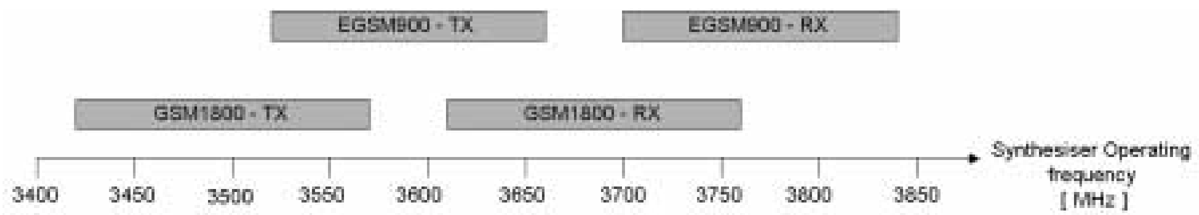
- If values shown are within limits select “Stop” and check “Save values to phone permanent memory”
- Select “Yes” to save values to phone
- Close the “TX Power Level Tuning” – dialog to end tuning

# Appendix

## Frequency mappings

The following figure shows the RX/TX operating frequency mapping to the frequency synthesizer operating frequency. For a more detailed list of actual channel number mappings see below.

**Figure 14: NHL-2NA VCO frequency mappings**



## E-GSM900

**Table 1: E-GSM900 Channel to VCO operating frequency mapping**

| 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 | 948 | 3612 | 3792 |
| 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 | 926 | 3524 | 3704 | 5 | 891 | 936 | 3564 | 3744 | 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 | 949 | 3616 | 3796 |
| 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 | 927 | 3528 | 3708 | 10 | 892 | 937 | 3568 | 3748 | 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 | 950 | 3620 | 3800 |
| 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 | 928 | 3532 | 3712 | 15 | 893 | 938 | 3572 | 3752 | 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 | 951 | 3624 | 3804 |
| 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 | 929 | 3536 | 3716 | 20 | 894 | 939 | 3576 | 3756 | 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 | 952 | 3628 | 3808 |
| 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 | 930 | 3540 | 3720 | 25 | 895 | 940 | 3580 | 3760 | 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 | 953 | 3632 | 3812 |
| 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 | 931 | 3544 | 3724 | 30 | 896 | 941 | 3584 | 3764 | 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 | 954 | 3636 | 3816 |
| 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 | 932 | 3548 | 3728 | 35 | 897 | 942 | 3588 | 3768 | 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 | 955 | 3640 | 3820 |
| 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 | 933 | 3552 | 3732 | 40 | 898 | 943 | 3592 | 3772 | 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 | 956 | 3644 | 3824 |
| 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 | 934 | 3556 | 3736 | 45 | 899 | 944 | 3596 | 3776 | 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 | 957 | 3648 | 3828 |
| 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 | 935 | 3560 | 3740 | 50 | 900 | 945 | 3600 | 3780 | 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 | 958 | 3652 | 3832 |
| | 54 | 900.8 | 945.8 | 3603.2 | 3783.2 | 116 | 913.2 | 958.2 | 3652.8 | 3832.8 |
| | 55 | 901 | 946 | 3604 | 3784 | 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 | 959 | 3656 | 3836 |
| | 59 | 901.8 | 946.8 | 3607.2 | 3787.2 | 121 | 914.2 | 959.2 | 3656.8 | 3836.8 |
| | 60 | 902 | 947 | 3608 | 3788 | 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

**Table 2: GSM1800 Channel to VCO operating frequency mapping**

| 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 | 638 | 1735.4 | 1830.4 | 3470.8 | 3660.8 | 764 | 1760.6 | 1855.6 | 3521.2 | 3711.2 |
| 513 | 1710.4 | 1805.4 | 6841.6 | 7221.6 | 639 | 1735.6 | 1830.6 | 3471.2 | 3661.2 | 765 | 1760.8 | 1855.8 | 3521.6 | 3711.6 |
| 514 | 1710.6 | 1805.6 | 6842.4 | 7222.4 | 640 | 1735.8 | 1830.8 | 3471.6 | 3661.6 | 766 | 1761 | 1856 | 3522 | 3712 |
| 515 | 1710.8 | 1805.8 | 6843.2 | 7223.2 | 641 | 1736 | 1831 | 3472 | 3662 | 767 | 1761.2 | 1856.2 | 3522.4 | 3712.4 |
| 516 | 1711 | 1806 | 6844 | 7224 | 642 | 1736.2 | 1831.2 | 3472.4 | 3662.4 | 768 | 1761.4 | 1856.4 | 3522.8 | 3712.8 |
| 517 | 1711.2 | 1806.2 | 6844.8 | 7224.8 | 643 | 1736.4 | 1831.4 | 3472.8 | 3662.8 | 769 | 1761.6 | 1856.6 | 3523.2 | 3713.2 |
| 518 | 1711.4 | 1806.4 | 6845.6 | 7225.6 | 644 | 1736.6 | 1831.6 | 3473.2 | 3663.2 | 770 | 1761.8 | 1856.8 | 3523.6 | 3713.6 |
| 519 | 1711.6 | 1806.6 | 6846.4 | 7226.4 | 645 | 1736.8 | 1831.8 | 3473.6 | 3663.6 | 771 | 1762 | 1857 | 3524 | 3714 |
| 520 | 1711.8 | 1806.8 | 6847.2 | 7227.2 | 646 | 1737 | 1832 | 3474 | 3664 | 772 | 1762.2 | 1857.2 | 3524.4 | 3714.4 |
| 521 | 1712 | 1807 | 6848 | 7228 | 647 | 1737.2 | 1832.2 | 3474.4 | 3664.4 | 773 | 1762.4 | 1857.4 | 3524.8 | 3714.8 |
| 522 | 1712.2 | 1807.2 | 6848.8 | 7228.8 | 648 | 1737.4 | 1832.4 | 3474.8 | 3664.8 | 774 | 1762.6 | 1857.6 | 3525.2 | 3715.2 |
| 523 | 1712.4 | 1807.4 | 6849.6 | 7229.6 | 649 | 1737.6 | 1832.6 | 3475.2 | 3665.2 | 775 | 1762.8 | 1857.8 | 3525.6 | 3715.6 |
| 524 | 1712.6 | 1807.6 | 6850.4 | 7230.4 | 650 | 1737.8 | 1832.8 | 3475.6 | 3665.6 | 776 | 1763 | 1858 | 3526 | 3716 |
| 525 | 1712.8 | 1807.8 | 6851.2 | 7231.2 | 651 | 1738 | 1833 | 3476 | 3666 | 777 | 1763.2 | 1858.2 | 3526.4 | 3716.4 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 526 | 1713 | 1808 | 6852 | 7232 | 652 | 1738.2 | 1833.2 | 3476.4 | 3666.4 | 778 | 1763.4 | 1858.4 | 3526.8 | 3716.8 |
| 527 | 1713.2 | 1808.2 | 6852.8 | 7232.8 | 653 | 1738.4 | 1833.4 | 3476.8 | 3666.8 | 779 | 1763.6 | 1858.6 | 3527.2 | 3717.2 |
| 528 | 1713.4 | 1808.4 | 6853.6 | 7233.6 | 654 | 1738.6 | 1833.6 | 3477.2 | 3667.2 | 780 | 1763.8 | 1858.8 | 3527.6 | 3717.6 |
| 529 | 1713.6 | 1808.6 | 6854.4 | 7234.4 | 655 | 1738.8 | 1833.8 | 3477.6 | 3667.6 | 781 | 1764 | 1859 | 3528 | 3718 |
| 530 | 1713.8 | 1808.8 | 6855.2 | 7235.2 | 656 | 1739 | 1834 | 3478 | 3668 | 782 | 1764.2 | 1859.2 | 3528.4 | 3718.4 |
| 531 | 1714 | 1809 | 6856 | 7236 | 657 | 1739.2 | 1834.2 | 3478.4 | 3668.4 | 783 | 1764.4 | 1859.4 | 3528.8 | 3718.8 |
| 532 | 1714.2 | 1809.2 | 6856.8 | 7236.8 | 658 | 1739.4 | 1834.4 | 3478.8 | 3668.8 | 784 | 1764.6 | 1859.6 | 3529.2 | 3719.2 |
| 533 | 1714.4 | 1809.4 | 6857.6 | 7237.6 | 659 | 1739.6 | 1834.6 | 3479.2 | 3669.2 | 785 | 1764.8 | 1859.8 | 3529.6 | 3719.6 |
| 534 | 1714.6 | 1809.6 | 6858.4 | 7238.4 | 660 | 1739.8 | 1834.8 | 3479.6 | 3669.6 | 786 | 1765 | 1860 | 3530 | 3720 |
| 535 | 1714.8 | 1809.8 | 6859.2 | 7239.2 | 661 | 1740 | 1835 | 3480 | 3670 | 787 | 1765.2 | 1860.2 | 3530.4 | 3720.4 |
| 536 | 1715 | 1810 | 6860 | 7240 | 662 | 1740.2 | 1835.2 | 3480.4 | 3670.4 | 788 | 1765.4 | 1860.4 | 3530.8 | 3720.8 |
| 537 | 1715.2 | 1810.2 | 6860.8 | 7240.8 | 663 | 1740.4 | 1835.4 | 3480.8 | 3670.8 | 789 | 1765.6 | 1860.6 | 3531.2 | 3721.2 |
| 538 | 1715.4 | 1810.4 | 6861.6 | 7241.6 | 664 | 1740.6 | 1835.6 | 3481.2 | 3671.2 | 790 | 1765.8 | 1860.8 | 3531.6 | 3721.6 |
| 539 | 1715.6 | 1810.6 | 6862.4 | 7242.4 | 665 | 1740.8 | 1835.8 | 3481.6 | 3671.6 | 791 | 1766 | 1861 | 3532 | 3722 |
| 540 | 1715.8 | 1810.8 | 6863.2 | 7243.2 | 666 | 1741 | 1836 | 3482 | 3672 | 792 | 1766.2 | 1861.2 | 3532.4 | 3722.4 |
| 541 | 1716 | 1811 | 6864 | 7244 | 667 | 1741.2 | 1836.2 | 3482.4 | 3672.4 | 793 | 1766.4 | 1861.4 | 3532.8 | 3722.8 |
| 542 | 1716.2 | 1811.2 | 6864.8 | 7244.8 | 668 | 1741.4 | 1836.4 | 3482.8 | 3672.8 | 794 | 1766.6 | 1861.6 | 3533.2 | 3723.2 |
| 543 | 1716.4 | 1811.4 | 6865.6 | 7245.6 | 669 | 1741.6 | 1836.6 | 3483.2 | 3673.2 | 795 | 1766.8 | 1861.8 | 3533.6 | 3723.6 |
| 544 | 1716.6 | 1811.6 | 6866.4 | 7246.4 | 670 | 1741.8 | 1836.8 | 3483.6 | 3673.6 | 796 | 1767 | 1862 | 3534 | 3724 |
| 545 | 1716.8 | 1811.8 | 6867.2 | 7247.2 | 671 | 1742 | 1837 | 3484 | 3674 | 797 | 1767.2 | 1862.2 | 3534.4 | 3724.4 |
| 546 | 1717 | 1812 | 6868 | 7248 | 672 | 1742.2 | 1837.2 | 3484.4 | 3674.4 | 798 | 1767.4 | 1862.4 | 3534.8 | 3724.8 |
| 547 | 1717.2 | 1812.2 | 6868.8 | 7248.8 | 673 | 1742.4 | 1837.4 | 3484.8 | 3674.8 | 799 | 1767.6 | 1862.6 | 3535.2 | 3725.2 |
| 548 | 1717.4 | 1812.4 | 6869.6 | 7249.6 | 674 | 1742.6 | 1837.6 | 3485.2 | 3675.2 | 800 | 1767.8 | 1862.8 | 3535.6 | 3725.6 |
| 549 | 1717.6 | 1812.6 | 6870.4 | 7250.4 | 675 | 1742.8 | 1837.8 | 3485.6 | 3675.6 | 801 | 1768 | 1863 | 3536 | 3726 |
| 550 | 1717.8 | 1812.8 | 6871.2 | 7251.2 | 676 | 1743 | 1838 | 3486 | 3676 | 802 | 1768.2 | 1863.2 | 3536.4 | 3726.4 |
| 551 | 1718 | 1813 | 6872 | 7252 | 677 | 1743.2 | 1838.2 | 3486.4 | 3676.4 | 803 | 1768.4 | 1863.4 | 3536.8 | 3726.8 |
| 552 | 1718.2 | 1813.2 | 6872.8 | 7252.8 | 678 | 1743.4 | 1838.4 | 3486.8 | 3676.8 | 804 | 1768.6 | 1863.6 | 3537.2 | 3727.2 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 553 | 1718.4 | 1813.4 | 6873.6 | 7253.6 | 679 | 1743.6 | 1838.6 | 3487.2 | 3677.2 | 805 | 1768.8 | 1863.8 | 3537.6 | 3727.6 |
| 554 | 1718.6 | 1813.6 | 6874.4 | 7254.4 | 680 | 1743.8 | 1838.8 | 3487.6 | 3677.6 | 806 | 1769 | 1864 | 3538 | 3728 |
| 555 | 1718.8 | 1813.8 | 6875.2 | 7255.2 | 681 | 1744 | 1839 | 3488 | 3678 | 807 | 1769.2 | 1864.2 | 3538.4 | 3728.4 |
| 556 | 1719 | 1814 | 6876 | 7256 | 682 | 1744.2 | 1839.2 | 3488.4 | 3678.4 | 808 | 1769.4 | 1864.4 | 3538.8 | 3728.8 |
| 557 | 1719.2 | 1814.2 | 6876.8 | 7256.8 | 683 | 1744.4 | 1839.4 | 3488.8 | 3678.8 | 809 | 1769.6 | 1864.6 | 3539.2 | 3729.2 |
| 558 | 1719.4 | 1814.4 | 6877.6 | 7257.6 | 684 | 1744.6 | 1839.6 | 3489.2 | 3679.2 | 810 | 1769.8 | 1864.8 | 3539.6 | 3729.6 |
| 559 | 1719.6 | 1814.6 | 6878.4 | 7258.4 | 685 | 1744.8 | 1839.8 | 3489.6 | 3679.6 | 811 | 1770 | 1865 | 3540 | 3730 |
| 560 | 1719.8 | 1814.8 | 6879.2 | 7259.2 | 686 | 1745 | 1840 | 3490 | 3680 | 812 | 1770.2 | 1865.2 | 3540.4 | 3730.4 |
| 561 | 1720 | 1815 | 6880 | 7260 | 687 | 1745.2 | 1840.2 | 3490.4 | 3680.4 | 813 | 1770.4 | 1865.4 | 3540.8 | 3730.8 |
| 562 | 1720.2 | 1815.2 | 6880.8 | 7260.8 | 688 | 1745.4 | 1840.4 | 3490.8 | 3680.8 | 814 | 1770.6 | 1865.6 | 3541.2 | 3731.2 |
| 563 | 1720.4 | 1815.4 | 6881.6 | 7261.6 | 689 | 1745.6 | 1840.6 | 3491.2 | 3681.2 | 815 | 1770.8 | 1865.8 | 3541.6 | 3731.6 |
| 564 | 1720.6 | 1815.6 | 6882.4 | 7262.4 | 690 | 1745.8 | 1840.8 | 3491.6 | 3681.6 | 816 | 1771 | 1866 | 3542 | 3732 |
| 565 | 1720.8 | 1815.8 | 6883.2 | 7263.2 | 691 | 1746 | 1841 | 3492 | 3682 | 817 | 1771.2 | 1866.2 | 3542.4 | 3732.4 |
| 566 | 1721 | 1816 | 6884 | 7264 | 692 | 1746.2 | 1841.2 | 3492.4 | 3682.4 | 818 | 1771.4 | 1866.4 | 3542.8 | 3732.8 |
| 567 | 1721.2 | 1816.2 | 6884.8 | 7264.8 | 693 | 1746.4 | 1841.4 | 3492.8 | 3682.8 | 819 | 1771.6 | 1866.6 | 3543.2 | 3733.2 |
| 568 | 1721.4 | 1816.4 | 6885.6 | 7265.6 | 694 | 1746.6 | 1841.6 | 3493.2 | 3683.2 | 820 | 1771.8 | 1866.8 | 3543.6 | 3733.6 |
| 569 | 1721.6 | 1816.6 | 6886.4 | 7266.4 | 695 | 1746.8 | 1841.8 | 3493.6 | 3683.6 | 821 | 1772 | 1867 | 3544 | 3734 |
| 570 | 1721.8 | 1816.8 | 6887.2 | 7267.2 | 696 | 1747 | 1842 | 3494 | 3684 | 822 | 1772.2 | 1867.2 | 3544.4 | 3734.4 |
| 571 | 1722 | 1817 | 6888 | 7268 | 697 | 1747.2 | 1842.2 | 3494.4 | 3684.4 | 823 | 1772.4 | 1867.4 | 3544.8 | 3734.8 |
| 572 | 1722.2 | 1817.2 | 6888.8 | 7268.8 | 698 | 1747.4 | 1842.4 | 3494.8 | 3684.8 | 824 | 1772.6 | 1867.6 | 3545.2 | 3735.2 |
| 573 | 1722.4 | 1817.4 | 6889.6 | 7269.6 | 699 | 1747.6 | 1842.6 | 3495.2 | 3685.2 | 825 | 1772.8 | 1867.8 | 3545.6 | 3735.6 |
| 574 | 1722.6 | 1817.6 | 6890.4 | 7270.4 | 700 | 1747.8 | 1842.8 | 3495.6 | 3685.6 | 826 | 1773 | 1868 | 3546 | 3736 |
| 575 | 1722.8 | 1817.8 | 3445.6 | 3635.6 | 701 | 1748 | 1843 | 3496 | 3686 | 827 | 1773.2 | 1868.2 | 3546.4 | 3736.4 |
| 576 | 1723 | 1818 | 3446 | 3636 | 702 | 1748.2 | 1843.2 | 3496.4 | 3686.4 | 828 | 1773.4 | 1868.4 | 3546.8 | 3736.8 |
| 577 | 1723.2 | 1818.2 | 3446.4 | 3636.4 | 703 | 1748.4 | 1843.4 | 3496.8 | 3686.8 | 829 | 1773.6 | 1868.6 | 3547.2 | 3737.2 |
| 578 | 1723.4 | 1818.4 | 3446.8 | 3636.8 | 704 | 1748.6 | 1843.6 | 3497.2 | 3687.2 | 830 | 1773.8 | 1868.8 | 3547.6 | 3737.6 |
| 579 | 1723.6 | 1818.6 | 3447.2 | 3637.2 | 705 | 1748.8 | 1843.8 | 3497.6 | 3687.6 | 831 | 1774 | 1869 | 3548 | 3738 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 580 | 1723.8 | 1818.8 | 3447.6 | 3637.6 | 706 | 1749 | 1844 | 3498 | 3688 | 832 | 1774.2 | 1869.2 | 3548.4 | 3738.4 |
| 581 | 1724 | 1819 | 3448 | 3638 | 707 | 1749.2 | 1844.2 | 3498.4 | 3688.4 | 833 | 1774.4 | 1869.4 | 3548.8 | 3738.8 |
| 582 | 1724.2 | 1819.2 | 3448.4 | 3638.4 | 708 | 1749.4 | 1844.4 | 3498.8 | 3688.8 | 834 | 1774.6 | 1869.6 | 3549.2 | 3739.2 |
| 583 | 1724.4 | 1819.4 | 3448.8 | 3638.8 | 709 | 1749.6 | 1844.6 | 3499.2 | 3689.2 | 835 | 1774.8 | 1869.8 | 3549.6 | 3739.6 |
| 584 | 1724.6 | 1819.6 | 3449.2 | 3639.2 | 710 | 1749.8 | 1844.8 | 3499.6 | 3689.6 | 836 | 1775 | 1870 | 3550 | 3740 |
| 585 | 1724.8 | 1819.8 | 3449.6 | 3639.6 | 711 | 1750 | 1845 | 3500 | 3690 | 837 | 1775.2 | 1870.2 | 3550.4 | 3740.4 |
| 586 | 1725 | 1820 | 3450 | 3640 | 712 | 1750.2 | 1845.2 | 3500.4 | 3690.4 | 838 | 1775.4 | 1870.4 | 3550.8 | 3740.8 |
| 587 | 1725.2 | 1820.2 | 3450.4 | 3640.4 | 713 | 1750.4 | 1845.4 | 3500.8 | 3690.8 | 839 | 1775.6 | 1870.6 | 3551.2 | 3741.2 |
| 588 | 1725.4 | 1820.4 | 3450.8 | 3640.8 | 714 | 1750.6 | 1845.6 | 3501.2 | 3691.2 | 840 | 1775.8 | 1870.8 | 3551.6 | 3741.6 |
| 589 | 1725.6 | 1820.6 | 3451.2 | 3641.2 | 715 | 1750.8 | 1845.8 | 3501.6 | 3691.6 | 841 | 1776 | 1871 | 3552 | 3742 |
| 590 | 1725.8 | 1820.8 | 3451.6 | 3641.6 | 716 | 1751 | 1846 | 3502 | 3692 | 842 | 1776.2 | 1871.2 | 3552.4 | 3742.4 |
| 591 | 1726 | 1821 | 3452 | 3642 | 717 | 1751.2 | 1846.2 | 3502.4 | 3692.4 | 843 | 1776.4 | 1871.4 | 3552.8 | 3742.8 |
| 592 | 1726.2 | 1821.2 | 3452.4 | 3642.4 | 718 | 1751.4 | 1846.4 | 3502.8 | 3692.8 | 844 | 1776.6 | 1871.6 | 3553.2 | 3743.2 |
| 593 | 1726.4 | 1821.4 | 3452.8 | 3642.8 | 719 | 1751.6 | 1846.6 | 3503.2 | 3693.2 | 845 | 1776.8 | 1871.8 | 3553.6 | 3743.6 |
| 594 | 1726.6 | 1821.6 | 3453.2 | 3643.2 | 720 | 1751.8 | 1846.8 | 3503.6 | 3693.6 | 846 | 1777 | 1872 | 3554 | 3744 |
| 595 | 1726.8 | 1821.8 | 3453.6 | 3643.6 | 721 | 1752 | 1847 | 3504 | 3694 | 847 | 1777.2 | 1872.2 | 3554.4 | 3744.4 |
| 596 | 1727 | 1822 | 3454 | 3644 | 722 | 1752.2 | 1847.2 | 3504.4 | 3694.4 | 848 | 1777.4 | 1872.4 | 3554.8 | 3744.8 |
| 597 | 1727.2 | 1822.2 | 3454.4 | 3644.4 | 723 | 1752.4 | 1847.4 | 3504.8 | 3694.8 | 849 | 1777.6 | 1872.6 | 3555.2 | 3745.2 |
| 598 | 1727.4 | 1822.4 | 3454.8 | 3644.8 | 724 | 1752.6 | 1847.6 | 3505.2 | 3695.2 | 850 | 1777.8 | 1872.8 | 3555.6 | 3745.6 |
| 599 | 1727.6 | 1822.6 | 3455.2 | 3645.2 | 725 | 1752.8 | 1847.8 | 3505.6 | 3695.6 | 851 | 1778 | 1873 | 3556 | 3746 |
| 600 | 1727.8 | 1822.8 | 3455.6 | 3645.6 | 726 | 1753 | 1848 | 3506 | 3696 | 852 | 1778.2 | 1873.2 | 3556.4 | 3746.4 |
| 601 | 1728 | 1823 | 3456 | 3646 | 727 | 1753.2 | 1848.2 | 3506.4 | 3696.4 | 853 | 1778.4 | 1873.4 | 3556.8 | 3746.8 |
| 602 | 1728.2 | 1823.2 | 3456.4 | 3646.4 | 728 | 1753.4 | 1848.4 | 3506.8 | 3696.8 | 854 | 1778.6 | 1873.6 | 3557.2 | 3747.2 |
| 603 | 1728.4 | 1823.4 | 3456.8 | 3646.8 | 729 | 1753.6 | 1848.6 | 3507.2 | 3697.2 | 855 | 1778.8 | 1873.8 | 3557.6 | 3747.6 |
| 604 | 1728.6 | 1823.6 | 3457.2 | 3647.2 | 730 | 1753.8 | 1848.8 | 3507.6 | 3697.6 | 856 | 1779 | 1874 | 3558 | 3748 |
| 605 | 1728.8 | 1823.8 | 3457.6 | 3647.6 | 731 | 1754 | 1849 | 3508 | 3698 | 857 | 1779.2 | 1874.2 | 3558.4 | 3748.4 |
| 606 | 1729 | 1824 | 3458 | 3648 | 732 | 1754.2 | 1849.2 | 3508.4 | 3698.4 | 858 | 1779.4 | 1874.4 | 3558.8 | 3748.8 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 607 | 1729.2 | 1824.2 | 3458.4 | 3648.4 | 733 | 1754.4 | 1849.4 | 3508.8 | 3698.8 | 859 | 1779.6 | 1874.6 | 3559.2 | 3749.2 |
| 608 | 1729.4 | 1824.4 | 3458.8 | 3648.8 | 734 | 1754.6 | 1849.6 | 3509.2 | 3699.2 | 860 | 1779.8 | 1874.8 | 3559.6 | 3749.6 |
| 609 | 1729.6 | 1824.6 | 3459.2 | 3649.2 | 735 | 1754.8 | 1849.8 | 3509.6 | 3699.6 | 861 | 1780 | 1875 | 3560 | 3750 |
| 610 | 1729.8 | 1824.8 | 3459.6 | 3649.6 | 736 | 1755 | 1850 | 3510 | 3700 | 862 | 1780.2 | 1875.2 | 3560.4 | 3750.4 |
| 611 | 1730 | 1825 | 3460 | 3650 | 737 | 1755.2 | 1850.2 | 3510.4 | 3700.4 | 863 | 1780.4 | 1875.4 | 3560.8 | 3750.8 |
| 612 | 1730.2 | 1825.2 | 3460.4 | 3650.4 | 738 | 1755.4 | 1850.4 | 3510.8 | 3700.8 | 864 | 1780.6 | 1875.6 | 3561.2 | 3751.2 |
| 613 | 1730.4 | 1825.4 | 3460.8 | 3650.8 | 739 | 1755.6 | 1850.6 | 3511.2 | 3701.2 | 865 | 1780.8 | 1875.8 | 3561.6 | 3751.6 |
| 614 | 1730.6 | 1825.6 | 3461.2 | 3651.2 | 740 | 1755.8 | 1850.8 | 3511.6 | 3701.6 | 866 | 1781 | 1876 | 3562 | 3752 |
| 615 | 1730.8 | 1825.8 | 3461.6 | 3651.6 | 741 | 1756 | 1851 | 3512 | 3702 | 867 | 1781.2 | 1876.2 | 3562.4 | 3752.4 |
| 616 | 1731 | 1826 | 3462 | 3652 | 742 | 1756.2 | 1851.2 | 3512.4 | 3702.4 | 868 | 1781.4 | 1876.4 | 3562.8 | 3752.8 |
| 617 | 1731.2 | 1826.2 | 3462.4 | 3652.4 | 743 | 1756.4 | 1851.4 | 3512.8 | 3702.8 | 869 | 1781.6 | 1876.6 | 3563.2 | 3753.2 |
| 618 | 1731.4 | 1826.4 | 3462.8 | 3652.8 | 744 | 1756.6 | 1851.6 | 3513.2 | 3703.2 | 870 | 1781.8 | 1876.8 | 3563.6 | 3753.6 |
| 619 | 1731.6 | 1826.6 | 3463.2 | 3653.2 | 745 | 1756.8 | 1851.8 | 3513.6 | 3703.6 | 871 | 1782 | 1877 | 3564 | 3754 |
| 620 | 1731.8 | 1826.8 | 3463.6 | 3653.6 | 746 | 1757 | 1852 | 3514 | 3704 | 872 | 1782.2 | 1877.2 | 3564.4 | 3754.4 |
| 621 | 1732 | 1827 | 3464 | 3654 | 747 | 1757.2 | 1852.2 | 3514.4 | 3704.4 | 873 | 1782.4 | 1877.4 | 3564.8 | 3754.8 |
| 622 | 1732.2 | 1827.2 | 3464.4 | 3654.4 | 748 | 1757.4 | 1852.4 | 3514.8 | 3704.8 | 874 | 1782.6 | 1877.6 | 3565.2 | 3755.2 |
| 623 | 1732.4 | 1827.4 | 3464.8 | 3654.8 | 749 | 1757.6 | 1852.6 | 3515.2 | 3705.2 | 875 | 1782.8 | 1877.8 | 3565.6 | 3755.6 |
| 624 | 1732.6 | 1827.6 | 3465.2 | 3655.2 | 750 | 1757.8 | 1852.8 | 3515.6 | 3705.6 | 876 | 1783 | 1878 | 3566 | 3756 |
| 625 | 1732.8 | 1827.8 | 3465.6 | 3655.6 | 751 | 1758 | 1853 | 3516 | 3706 | 877 | 1783.2 | 1878.2 | 3566.4 | 3756.4 |
| 626 | 1733 | 1828 | 3466 | 3656 | 752 | 1758.2 | 1853.2 | 3516.4 | 3706.4 | 878 | 1783.4 | 1878.4 | 3566.8 | 3756.8 |
| 627 | 1733.2 | 1828.2 | 3466.4 | 3656.4 | 753 | 1758.4 | 1853.4 | 3516.8 | 3706.8 | 879 | 1783.6 | 1878.6 | 3567.2 | 3757.2 |
| 628 | 1733.4 | 1828.4 | 3466.8 | 3656.8 | 754 | 1758.6 | 1853.6 | 3517.2 | 3707.2 | 880 | 1783.8 | 1878.8 | 3567.6 | 3757.6 |
| 629 | 1733.6 | 1828.6 | 3467.2 | 3657.2 | 755 | 1758.8 | 1853.8 | 3517.6 | 3707.6 | 881 | 1784 | 1879 | 3568 | 3758 |
| 630 | 1733.8 | 1828.8 | 3467.6 | 3657.6 | 756 | 1759 | 1854 | 3518 | 3708 | 882 | 1784.2 | 1879.2 | 3568.4 | 3758.4 |
| 631 | 1734 | 1829 | 3468 | 3658 | 757 | 1759.2 | 1854.2 | 3518.4 | 3708.4 | 883 | 1784.4 | 1879.4 | 3568.8 | 3758.8 |
| 632 | 1734.2 | 1829.2 | 3468.4 | 3658.4 | 758 | 1759.4 | 1854.4 | 3518.8 | 3708.8 | 884 | 1784.6 | 1879.6 | 3569.2 | 3759.2 |
| 633 | 1734.4 | 1829.4 | 3468.8 | 3658.8 | 759 | 1759.6 | 1854.6 | 3519.2 | 3709.2 | 885 | 1784.8 | 1879.8 | 3569.6 | 3759.6 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 634 | 1734.6 | 1829.6 | 3469.2 | 3659.2 | 760 | 1759.8 | 1854.8 | 3519.6 | 3709.6 | |
| 635 | 1734.8 | 1829.8 | 3469.6 | 3659.6 | 761 | 1760 | 1855 | 3520 | 3710 | |
| 636 | 1735 | 1830 | 3470 | 3660 | 762 | 1760.2 | 1855.2 | 3520.4 | 3710.4 | |
| 637 | 1735.2 | 1830.2 | 3470.4 | 3660.4 | 763 | 1760.4 | 1855.4 | 3520.8 | 3710.8 | |

# UI Troubleshooting

## Introduction

UI module includes LCD display and backlight, four keydomes and a 5-way switch also known as rocker. This document describes it's troubleshooting.

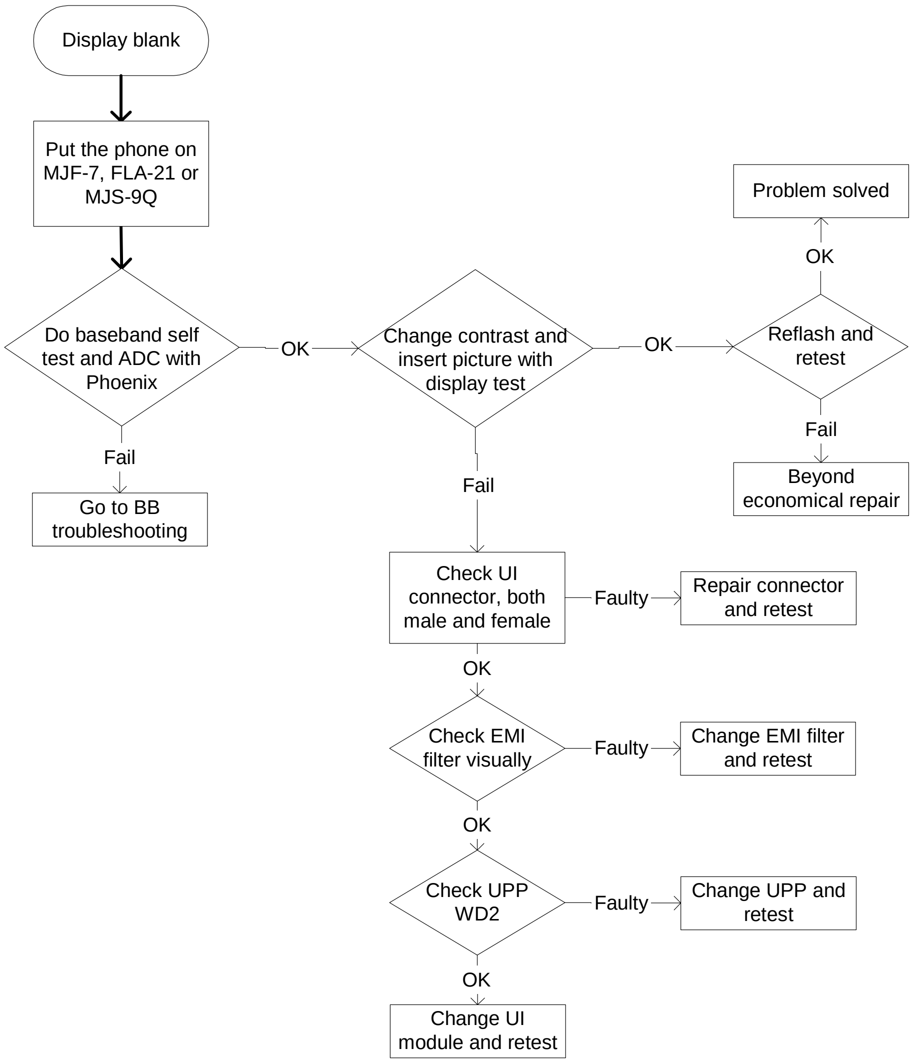
The LCD displays may have bright pixels or dark pixels that are visible with some colors. These are characteristic to active matrix LCD's and do not cause a change of UI module.

Each UI module has a different contrast point. That point can vary more than the end user has possibility to adjust. Therefore every time you change the UI module, you need to adjust the contrast point.

## UI module troubleshooting cases

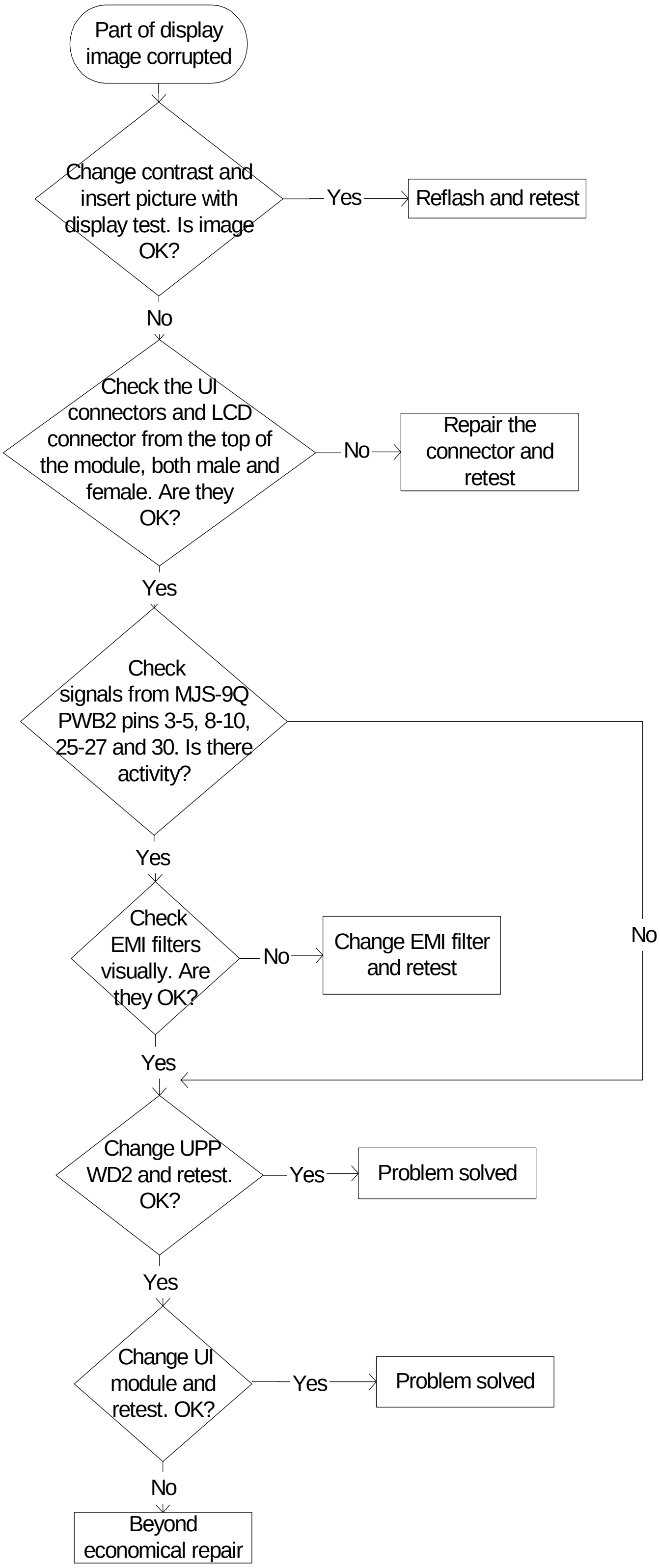
### Display blank

There is no image on the display. Display looks the same when the phone is on as it does when the phone is off.



## Image on display not correct

Image on the display can be corrupted or part of the image can be missing. If part of image is missing change the UI module. If the image is otherwise corrupted, follow the path below.



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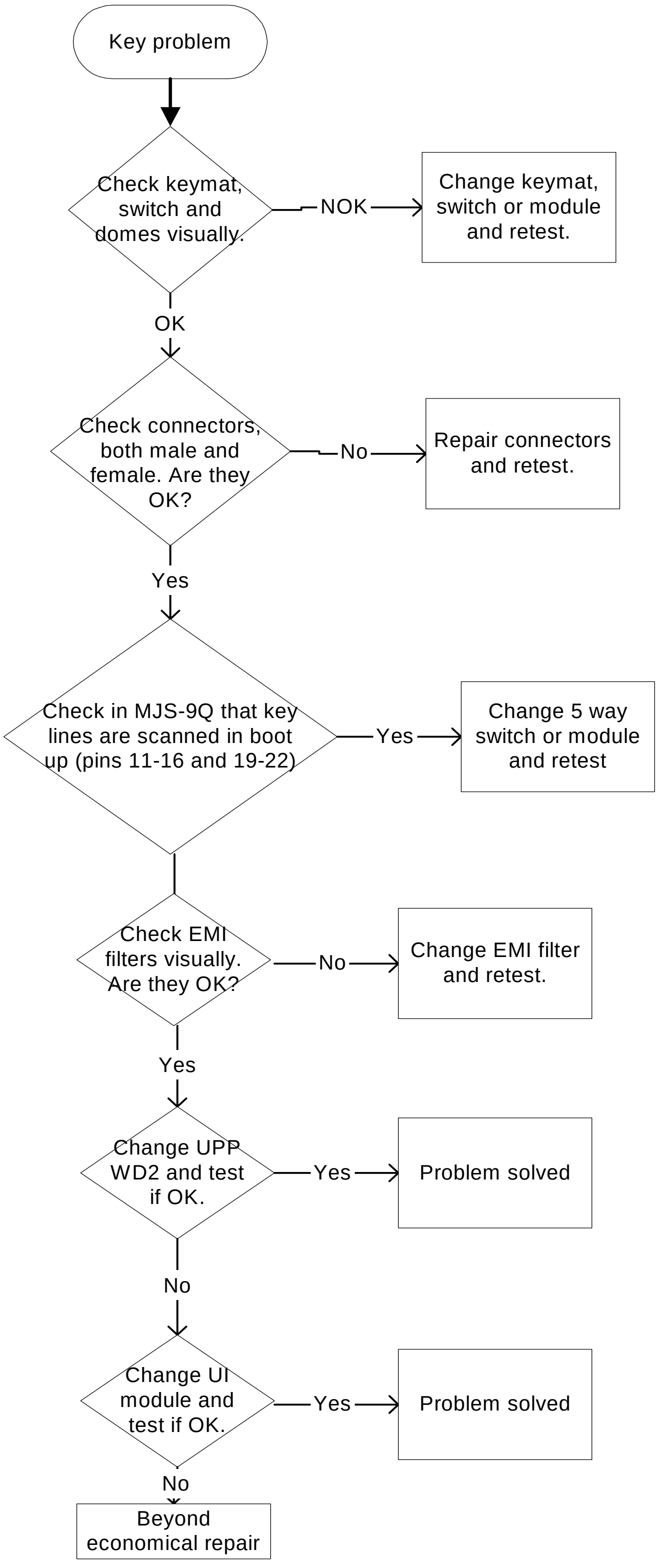
### Key or 5-way switch not working

UI module includes 5-way switch, application key, voice recorder key and two softkeys.



# Grip-Module Troubleshooting

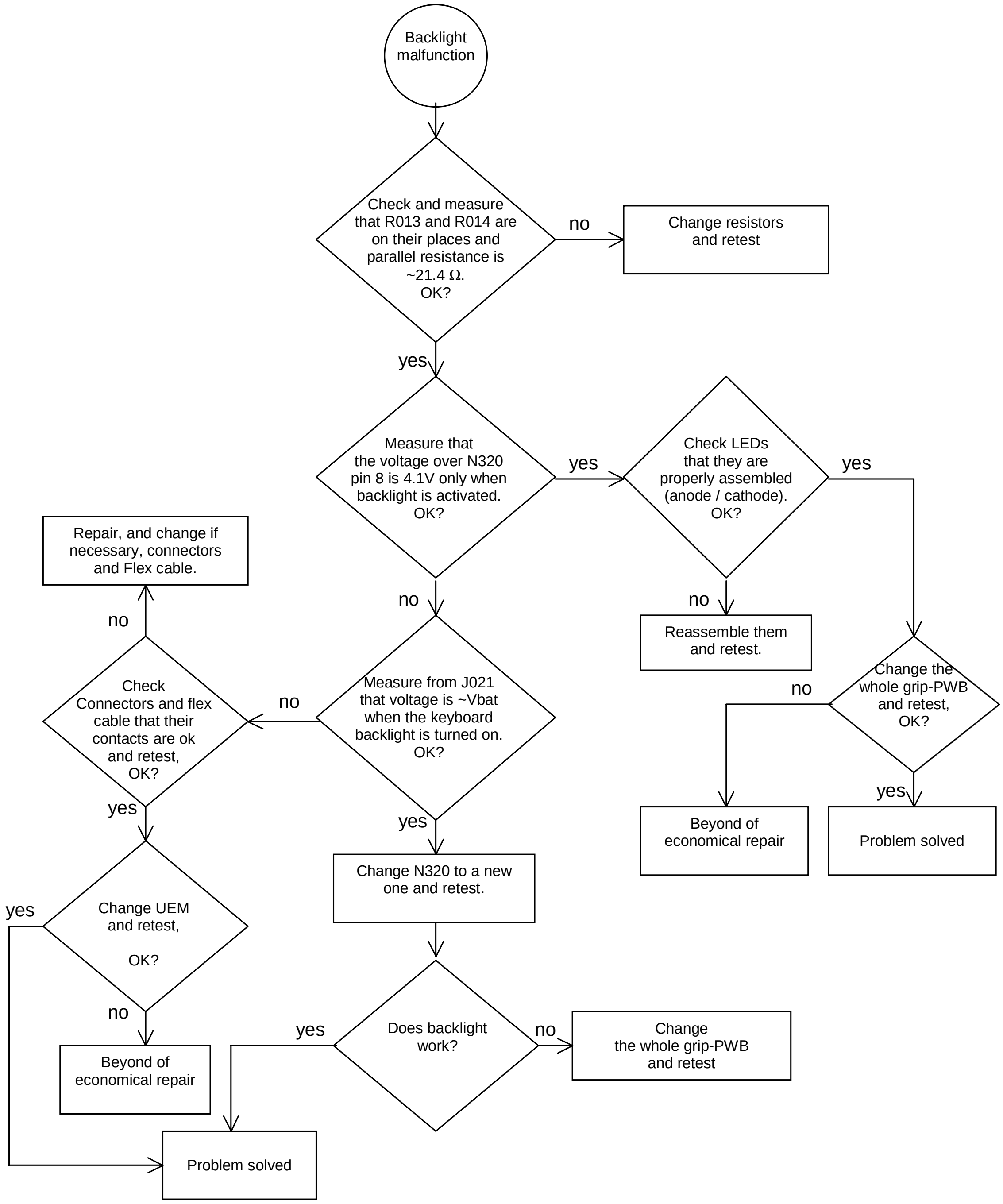
## Introduction

This section describes how the troubleshooting should be done if there is something wrong with the Nokia 7650 Grip-module (LS4). All parts of the Grip-module - the back-light, current gauge, vibra, keyboard and hall-sensor - have their own flowcharts that describe how problems can be solved. Although the hall-sensor is located in the LG4, its troubleshooting is described in this section.

The following flow charts have some links to each other so they are linked to each other, and in this way, the root cause of a problem can be solved. Please note also that there is a separate troubleshooting section with flowcharts for the transceiver board (LG4).

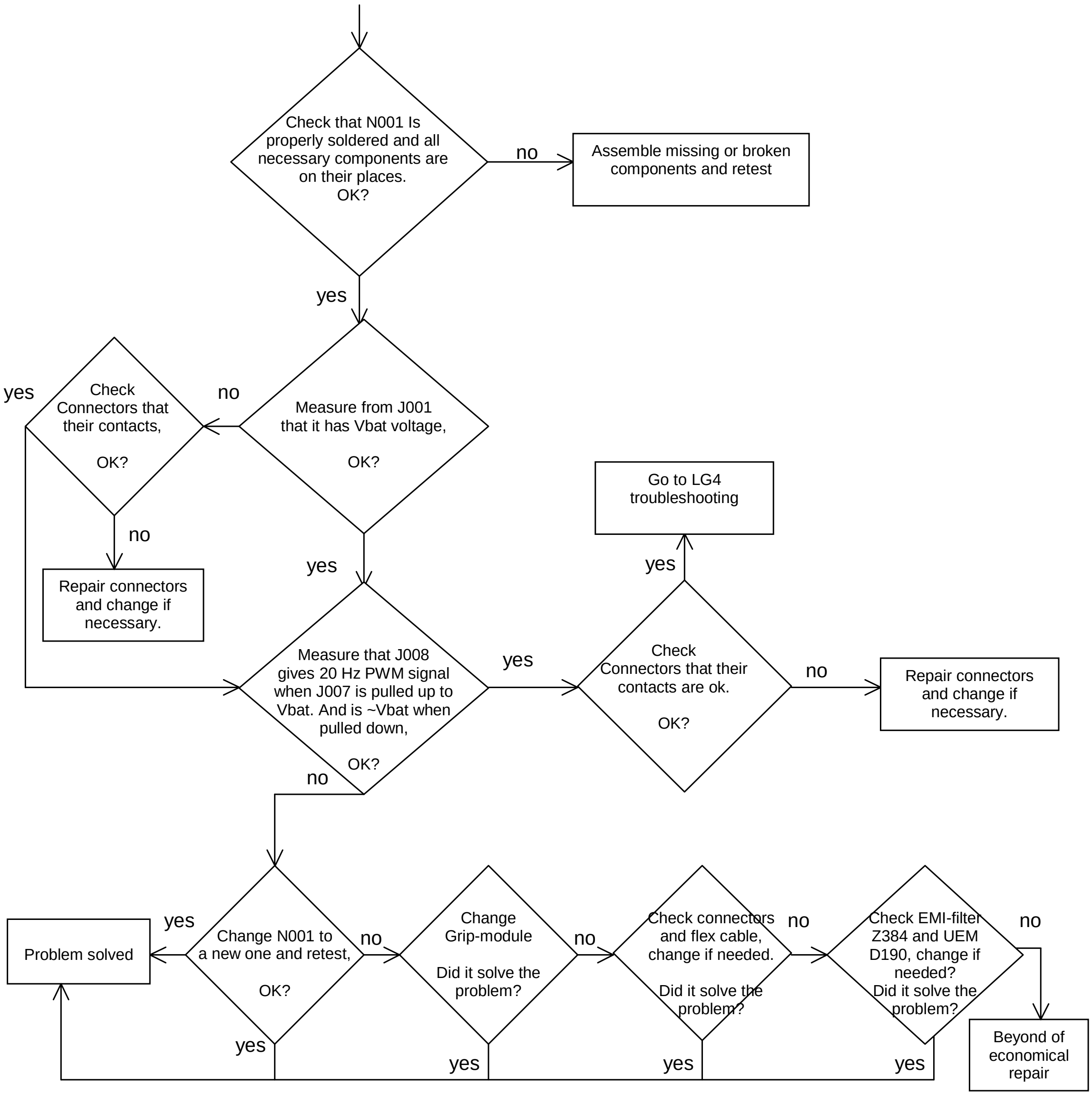
## Backlight

There are basically two kind of problems with the keyboard backlight. The backlight may be dim or there there may be no backlight at all. The following flowchart describes how these two problems can be detected and solved.



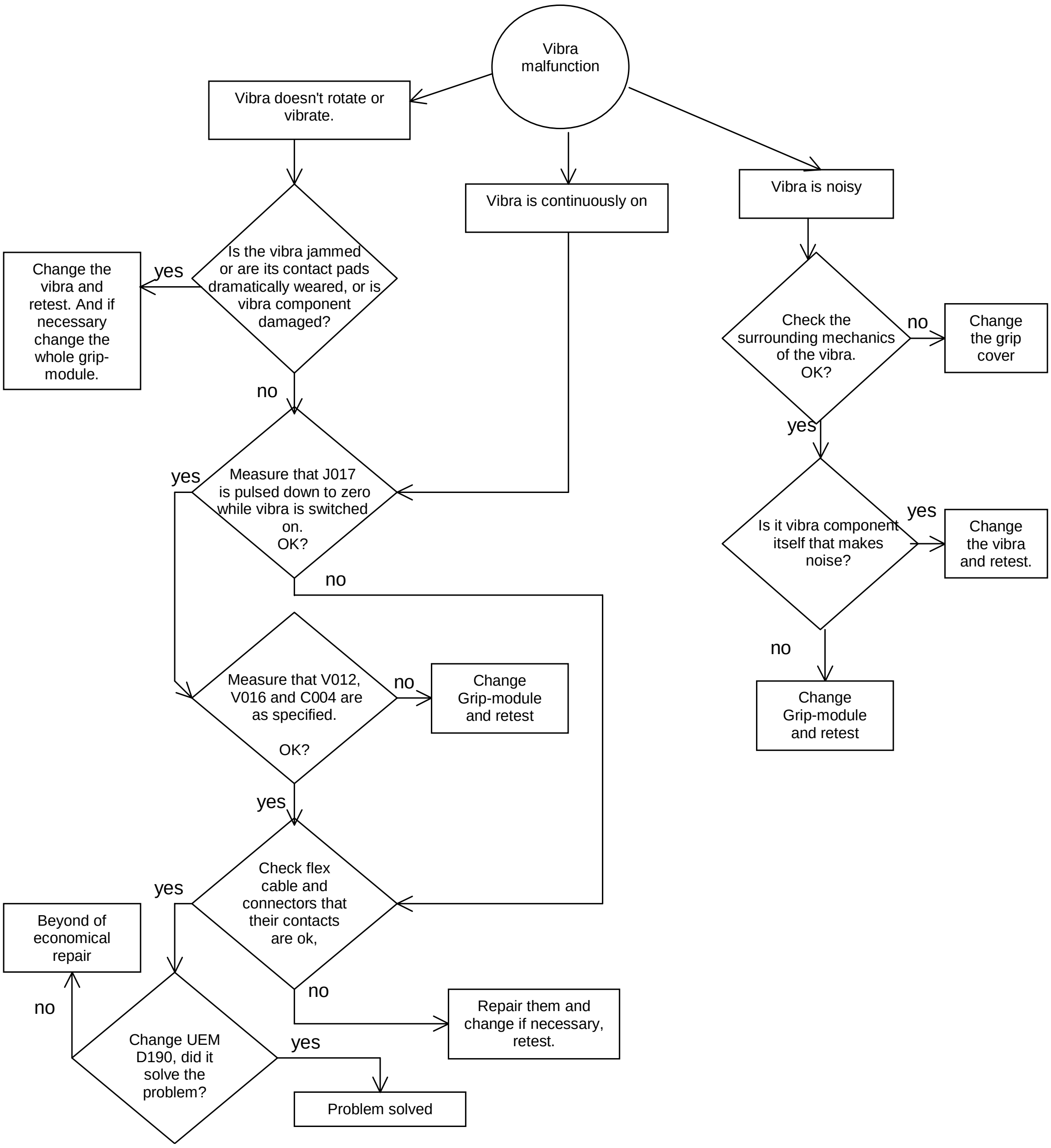
## Current Gauge

There are basically three kinds of problems that may occur concerning the current gauge: (1) the PWM signal is out of the specification, (2) it does not give a PWM signal at all or (3) the gauge does not react its shut down signal. The user notices a current gauge problem when the phone never stops charging.



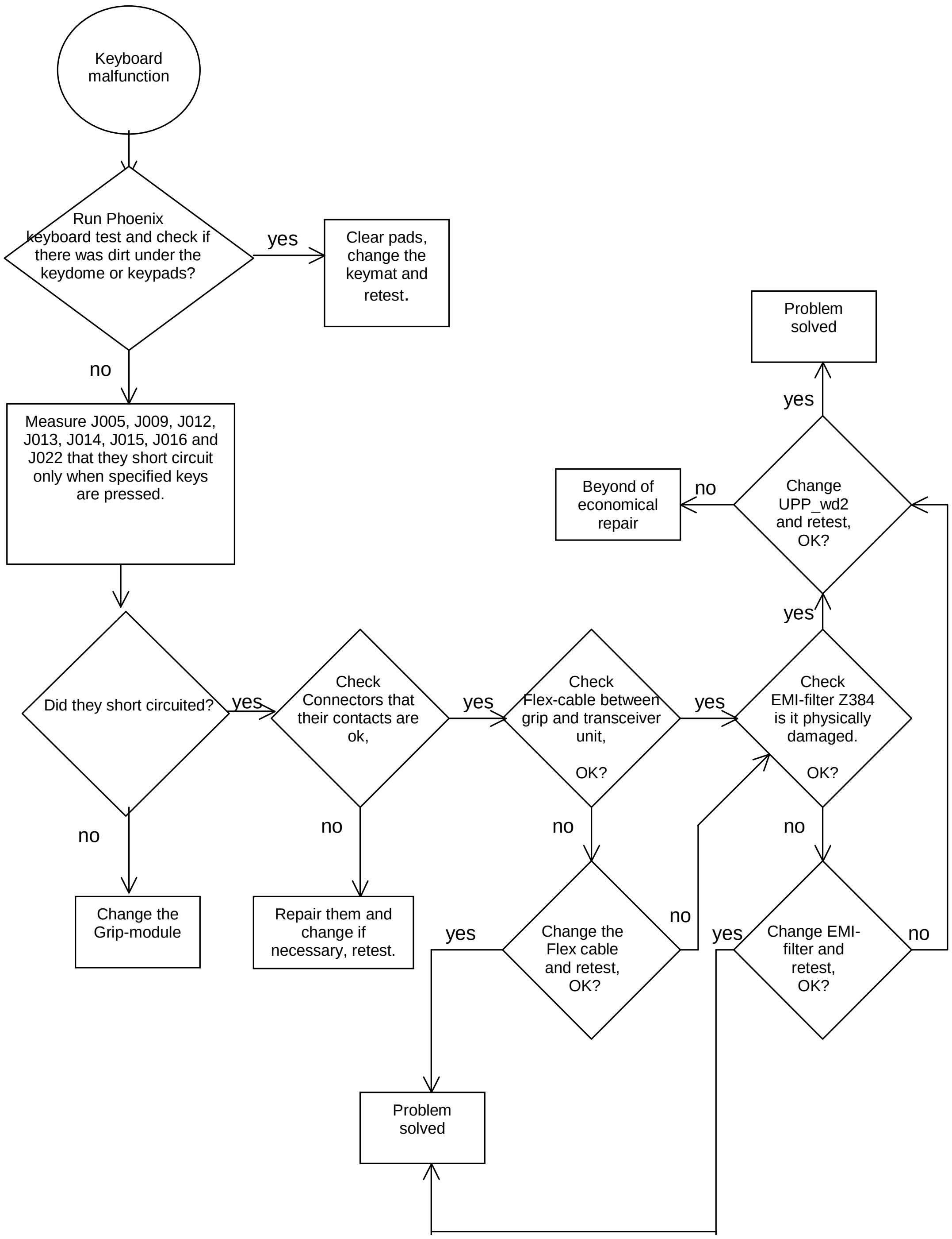
## Vibra

There are basically three kind of problems concerning the vibra: (1) it does not rotate at all, (2) it is noisy or (3) it is continously on. The noisiness is usually caused by the surrounding mechanics when the rotating mass has contact to it.



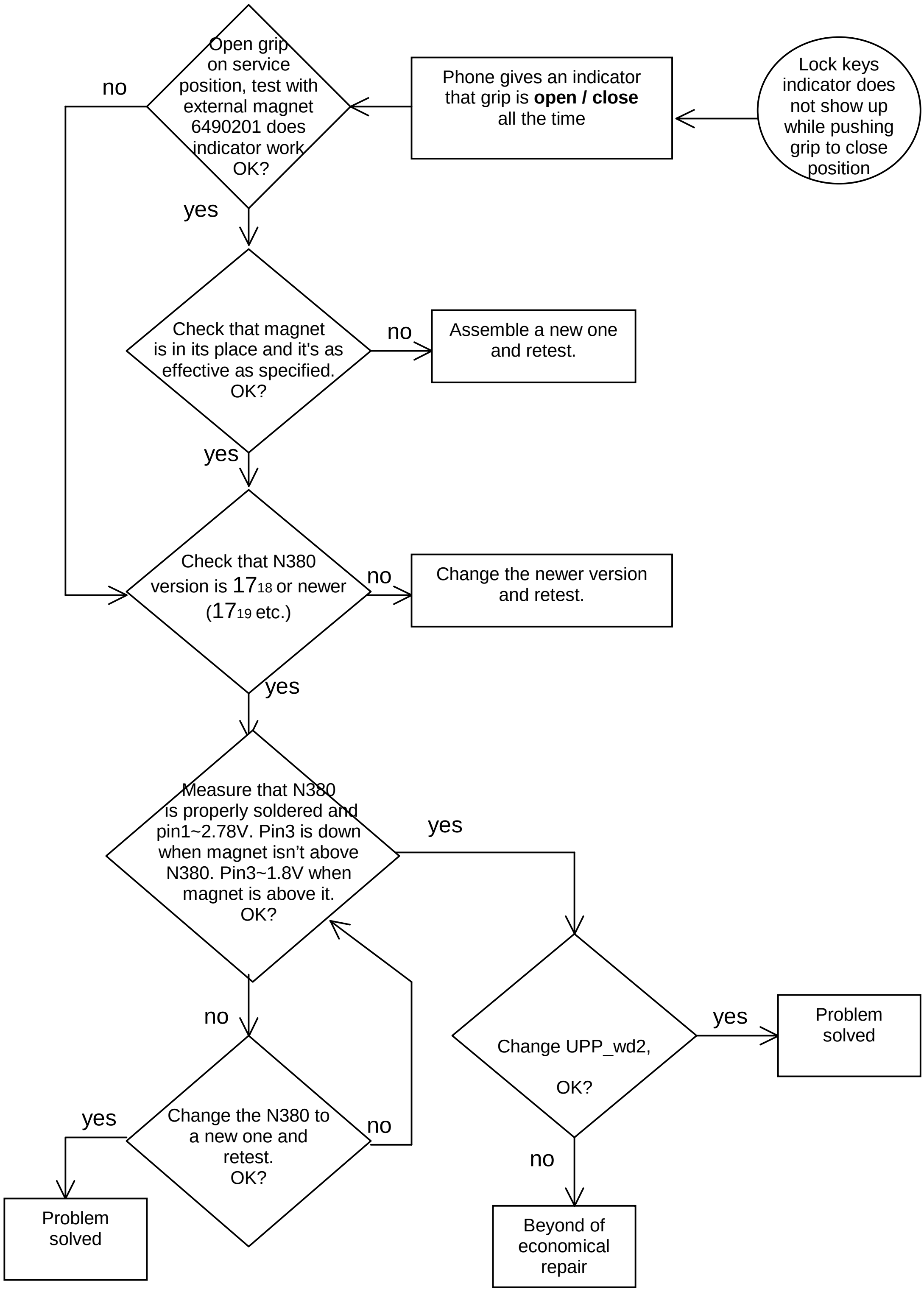
## Keyboard

If the Grip keyboard does not work, follow the troubleshooting path in the flowchart below.



## Hall Sensor

There are two possible malfunction concerning the hall sensor: the output of the hall sensor stays on high or low regardless the position of the magnet.



# Camera Troubleshooting Instructions

## Background, tools and terminology

A fault or complaint associated to camera operation can be roughly categorized to three subgroups:

1 Camera is not functional at all, no image can be obtained
2 Images can be taken but there is nothing recognizable in them
3 Images can be taken and they are recognizable but for some reason the quality of images is seriously degraded, or customer complains about image quality

Type 1 and 2 faults are most often similar to what traditionally has been found in any electronic devices. Type 3 faults are new to NMP and maybe the most challenging to find and verify.

Image quality is very hard to measure quantitatively, and even comparative measurements are difficult (comparing two images) if the difference is small. Especially if the user is not satisfied with his/her devices' image quality, and tells e.g. that the images are not sharp, it is fairly difficult to accurately test the device and get an exact figure which then would tell if the device is OK or not.

Most often, subjective evaluation has to be used for finding out if a certain property of the camera is acceptable or not. Some training or experience of a correctly operating reference device may be needed in order to detect what actually is wrong, or is there anything wrong at all. It is easy for the user to take bad looking images in bad conditions; thus the camera operation has to be checked always in constant conditions (lighting, temperature) or by using a second, known to be good device as a reference. Experience significantly helps in analyzing image quality.

### Terms

**Dynamic range:** camera's ability to capture details in dark and bright areas of the scene simultaneously. See Image which has been taken "against light". The actual object is dark. for example.

**Exposure time:** camera modules use silicon sensor to collect light and for forming an image. The imaging process roughly corresponds to traditional film photography, in which exposure time means the time during which the film is exposed to light coming through optics. Increasing the time will allow for more light hitting the film and thus results in brighter image. The operation principle is exactly the same with silicon sensor, but the shutter functionality is handled electronically i.e. there is no mechanical moving parts like in film cameras.

**Flicker:** Phenomena, which is caused by pulsating in scene lighting, typically appearing as wide horizontal stripes in image.

**Noise:** Variation of response between pixels with same level of input illumination. See e.g. Noisy image taken in +70 degrees celsius for example of noisy image.

**Resolution:** Usually the amount of pixels in the camera sensor, e.g. VGA means 640 x 480 pixels. In some occasions the term resolution is used for describing the sharpness of the images.

**Sensitivity:** camera module's sensitivity to light. In equivalent illumination conditions, a less sensitive camera needs longer exposure time to gather enough light for forming a good image. Analogous to ISO speed in photographic film.

**Sharpness:** camera's images are ideally 'sharp' or 'crisp', meaning that image details are well visible in the picture. However, certain issues like non-idealities in optics, cause image blurring, making objects in picture to appear 'soft'. Each camera type typically has it's own level of performance.

## Image taking conditions effect to image quality

This chapter lists some of the factors, which may cause poor image quality if not taken into account by end user when shooting pictures, and thus may result in complaints. **The listed items are normal to camera operation and do not cause a need for e.g. changing the camera module.**

Distance to target: the lens in the module is specified to operate satisfactorily from 30cm to infinite distance of scene objects. In practice, the operation is such that close objects may be noticed to get more blurred when distance to them is shortened from 40cm. Lack of sharpness will be first visible in full resolution (VGA) images. If observing just the viewfinder, even very close objects may seem to appear sharp. *This is normal behavior, do not change the camera module.*

**Figure 1: Image blurred due to too close distance to target (5 cm)**


Sharpness of picture edges: lens performance degrades in image edges, and generally the image is sharpest in center part. Particularly this applies to distant objects (> 1 meter). With near objects (about 5 cm – 30 cm) the lens behaves so that center of the image may not be the sharpest point, instead maximum sharpness is approximately in half way from center to edges. This phenomena can particularly be seen in images which have small details over the whole image area, such as grass or similar; See Sharpness of picture is worse on the edges than in the centre. *This is normal behavior, do not change the camera module.*

**Figure 2: Sharpness of picture is worse on the edges than in the centre**

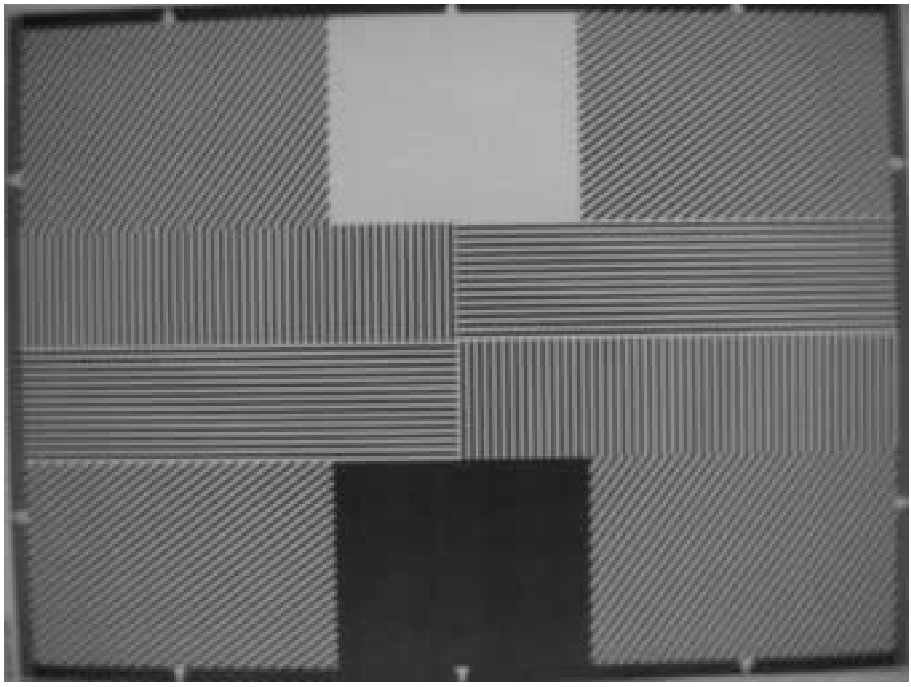


**Figure 3: Especially this type of images are affected much by lack of sharpness in edges / corners**

Geometrical distortion: camera lens will cause some amount of so called barrel distortion in images. In practice, this appears as bending of straight objects in edges of the image. See Geometrical distortion and Handshake has caused blurring of this image. Note geometrical barrel distortion in background for example. *This is normal behavior, do not change the camera module.*

**Figure 4: Geometrical distortion**

Amount of light available: in dim conditions camera runs out of sensitivity. Exposure time is long (especially in night mode) and the risk of getting shaken (= blurred) images grows. Image noise level grows. The maximum exposure time in night mode is ¼ seconds, so images need to be taken with extreme care and by supporting the phone when the amount of light reflected from the target is low. Sometimes blurring may even happen at daytime if image is taken very carelessly. See Handshake has caused blurring of this image. Note geometrical barrel distortion in background for example. *This is normal behavior, do not change the camera module.*

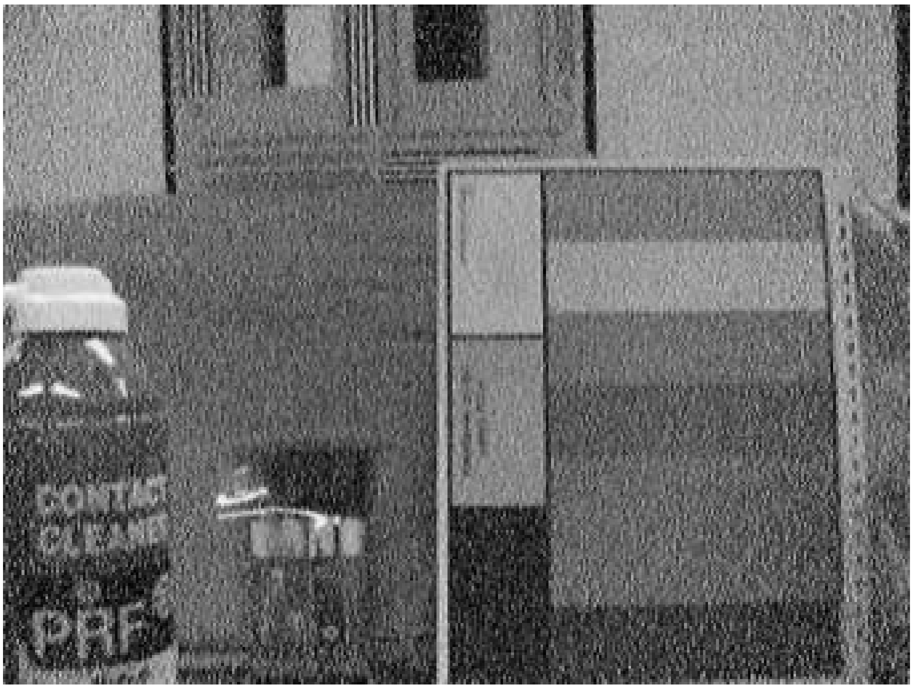
**Figure 5: Handshake has caused blurring of this image. Note geometrical barrel distortion in background**

Movement in bright light: If pictures of moving objects are taken or if the device is used in a moving car, object 'skewing' or 'tilting' will occur. This phenomena is fundamental to most CMOS camera types and normal, and can not be helped. Movement of camera or object will usually cause blurring in inside or dim lighting conditions due to long exposure time. *This is normal behavior, do not change the camera module.*

**Figure 6: Near objects in image get skewed when shooting from a moving car**

Temperature: high temperatures inside the mobile phone will cause more noise to appear in images, e.g. in +70 degrees of celsius the noise level may be very high, and it further grows if the conditions are dim. This is also normal to camera operation. *This is normal behavior, do not change the camera module.*

**Figure 7: Noisy image taken in +70 degrees celsius**



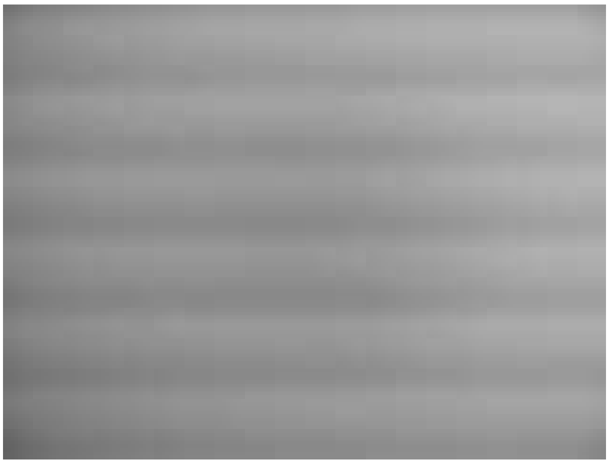
Phone display: if the display contrast is set too dark, the image quality degrades quite much: the images may be very dark, naturally depending on the setting. If display contrast is set too bright, image contrast appears bad and "faint". This flaw is easily cured by setting the display contrast to correct value. *This is normal behavior, do not change the camera module.*

Basic rules of photography, especially shooting against light: electronic image sensors typically have much lower dynamic range than what films have. In practice this means that when taking a picture inside e.g. having a window behind object, will produce poor results. *This is normal behavior, do not change the camera module.*

**Figure 8: Image which has been taken "against light". The actual object is dark.**

Flicker: in some occasions a bright fluorescent light may cause flicker to be seen in the viewfinder and captured image. This phenomena may also result if pictures are taken indoors under mismatch of 50/60 Hz electricity network frequency. The frequency will be detected from operator country sign information. In some very few countries, both 50 and 60 Hz networks are present and thus probability for the phenomena grows. *This is normal behavior, do not change the camera module.*

**Figure 9: Flicker in image of white, uniform object illuminated by strong fluorescent light**



Bright light outside of image view: Especially sun can cause clearly visible 'halo' effects and poor contrast in images. This happens due to unwanted reflections inside camera optics. Generally this kind of reflections are common in all optical systems. *This is normal behavior, do not change the camera module.*

Figure 10: A lens reflection effect caused by sun shining above the scene

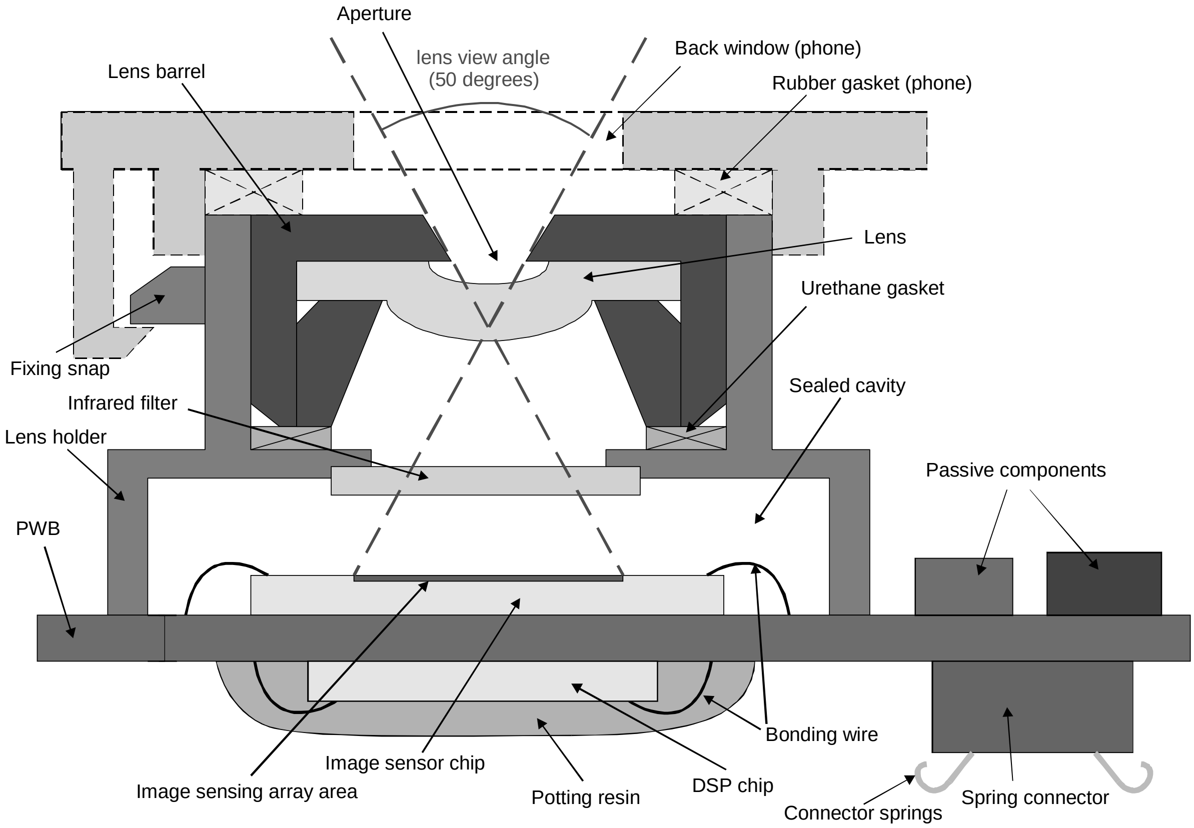
Figure 11: A good picture taken indoors

Figure 12: A good picture taken outdoors

## Camera construction

In this section, some information of the actual construction of the camera module is given for getting understanding of the actual mechanical structure of the module.

**Figure 13: Cross section of the camera module (NMP part # 4858001) and assembly principle (dash line showing phone parts)**




The camera module as a component is not a repairable part i.e. components in the module may not be changed. Cleaning dust from the front face is the only allowable operation, do this by using clean compressed air.

Cross section of the camera module (NMP part # 4858001) and assembly principle (dash line showing phone parts) shows the cross section view of the camera module and the principle of fixing it to a phone. The main parts of the module are

- Threaded lens barrel, containing the lens itself and the lens aperture
- Infrared filter, which is used to prevent infrared light from contaminating the image colors. IR filter is glued to the lens holder
- lens holder, which is made of conductive, metallized plastic and attached to PWB by glue
- Image sensor, which is glued and wire bonded to PWB
- PWB, FR-4 type
- Hard wired DSP chip, which is wire bonded and potted to underside of the module
- Spring connector with 13 contact springs, containing the component type information (laser marked on the surface)
- Passive components

## Image quality analysis

### Possible faults in image quality

When checking for possible errors in camera functionality, knowing what error is suspected will significantly help the testing by narrowing down the amount of test cases. The following types of image quality problems may be expected to appear (in order of appearance probability):

- Dust (black spots)
- Lack of sharpness
- Bit errors

In addition, there are many other kinds of possibilities for getting bad image quality, but those are ruled out from the scope of this document since probability of their appearance is going to be minimized by production testing.

### Testing for dust

For detecting this kind of problems, take an image of uniform white surface and analyze it in full resolution; search carefully – finding these defects is not always easy. Effects of dust in optical path is an example of image containing easily detectable dust problems.

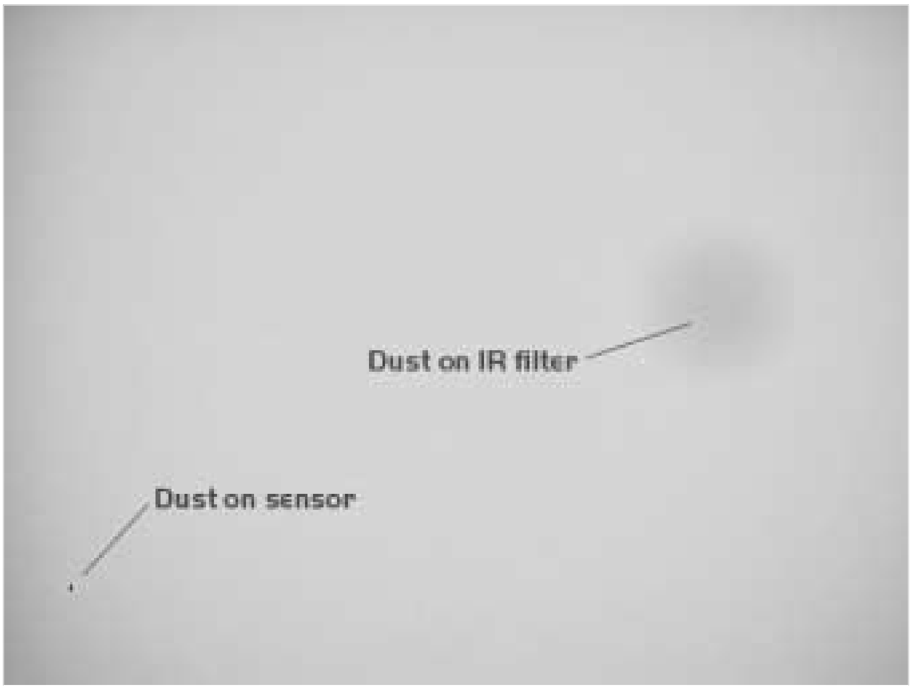
For taking an uniform white image: The best results are obtained using the docking station adapter MJF-7. Care should be taken that the diffuser (white) surface of the adapter is clean.

If adapter is not available, uniform white target such as a clean, straight white sheet of paper, may be used, but extreme care should be taken to arrange illumination conditions so that the target is uniformly illuminated.

Black spots in image are caused by dirt particles trapped into the optical system: clearly visible and sharp edged black dots in image are typically dust particles on image sensor. These spots are searched for in manufacturing phase, but it is possible that the lens holder cavity contains a particle, which may move onto the image sensor active surface, e.g. when the phone is dropped. Thus it is also possible that the problem will disappear before the phone is brought to service. The camera should be replaced if the problem is present when the service technician analyses the phone.

If dust particles are located on infrared filter surface on either side, they are much harder to locate because they will be out of focus, and appear in image as large, grayish and fading-edge 'blobs'. Sometimes they will be very hard to find, and thus the user probably will not notice them at all since they do no harm. But it is possible that a larger particle disturbs the user, causing need for service.

Figure 14: Effects of dust in optical path




If large dust particles get trapped on top of the lens surface in the cavity between camera window and lens, they will cause image blurring and poor contrast (see also item 'sharpness'). The seal between the window and lens should prevent any particles from getting into the cavity after manufacturing phase.

If dust particles are found on sensor, this is classified as a manufacturing error of the module and thus the camera should be replaced. Any particles inside the cavity between window and lens have most probably been trapped there in assembly phase in Nokia factory. It is of course also possible that the user has disassembled the device and caused the problem. However, in most cases it should be possible to remove the particle(s) by using clean compressed air. Never wipe the lens surface before trying compressed air; the possibility of damaging the lens is substantial. Always check the image sharpness after removing dust.

### Testing for sharpness

If pictures taken with some device are claimed to be blurry, there are four possible sources for the claim:

1. Back window is fingerprinted, soiled, dirty, visibly scratched or broken
2. User has tried to take a picture of a too close object – lens operates with distances from 30 cm to infinity
3. User has tried to take pictures in too dark conditions and images are blurred due to handshake or movement. This is no cause to replace camera module
4. There is dirt between back window and camera lens
5. The back window is defective (somehow passed through window manufacturer's inspection). Window should be changed
6. Camera lens is unfocused (somehow passed through camera manufacturer's inspection)

Quantitative analysis of sharpness is very difficult to conduct in other than optics laboratory environment. Thus subjective analysis should be used.

If no visible defects (items 1-4) can be found, a couple of test images should be taken and checked. Generally, a well illuminated typical indoor office scene, such as the one in A good picture taken indoors, can be used as a target. The main considerations are:

- The back window has to be clean
- Amount of light: 300 – 600 lux (bright office lighting) is sufficient
- The scene should contain e.g. small objects for checking sharpness and distance to them should be in order of 1 – 2 meters
- If possible, compare the image to another image of the same scene, taken by different device

The taken images should be analyzed on PC screen at 100% scaling simultaneously with reference image. Pay attention to the computer display settings; at least 65000 colors (16 bit) have to be used. 256 (8-bit) color setting is not sufficient, and true color (24 bit, 16 million colors) or 32 bit (full color) setting is recommended.

If there appears to be a clearly noticeable difference between the reference image and the test images, the module might have misfocused lens. In this case, the module should be changed. Always re-check the resolution after changing the camera. If a different module produces the same result, the fault is probably in camera window. Check the window by seeing through it when replacing the module.

**Effects of dirty or defective back window**

The following series of images demonstrates the effects of fingerprints on the camera back window.

It should be noted that the effects of any dirt in images can vary very much; it may be difficult to judge if the window has been dirty when some image has been taken or that has something else been wrong. That is why the cleanness of the back window should always be checked and the window should be wiped clean with a suitable cloth.

Figure 15: Image taken with clear back window

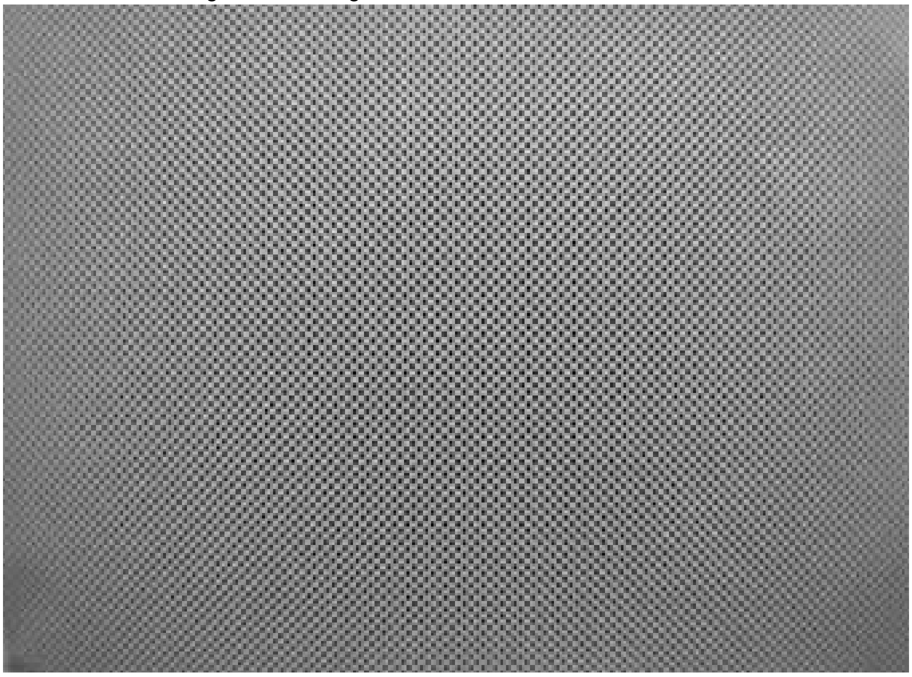


Figure 16: Image taken with a faint fingerprint on back window

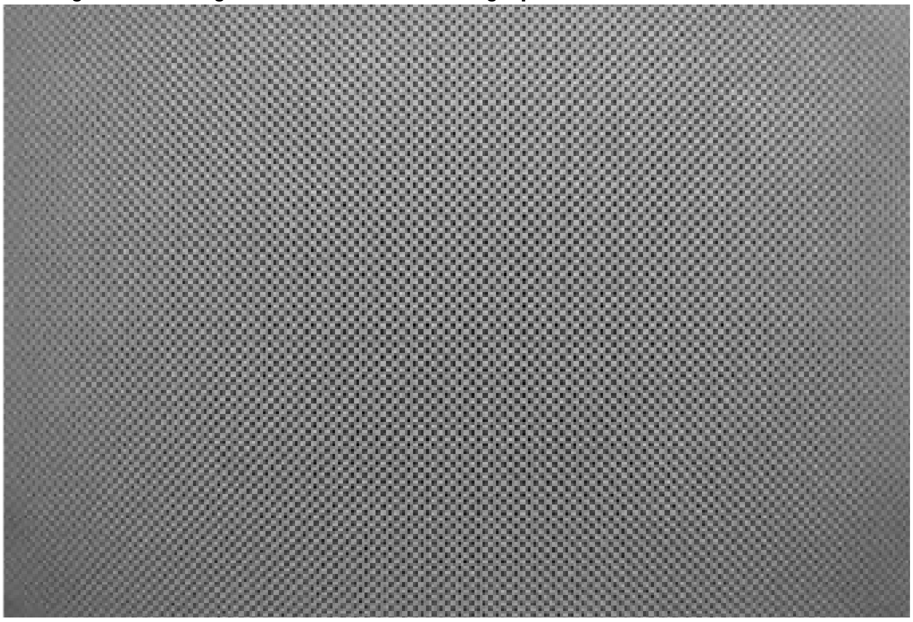


Figure 17: Image taken with a thick fingerprint on back window

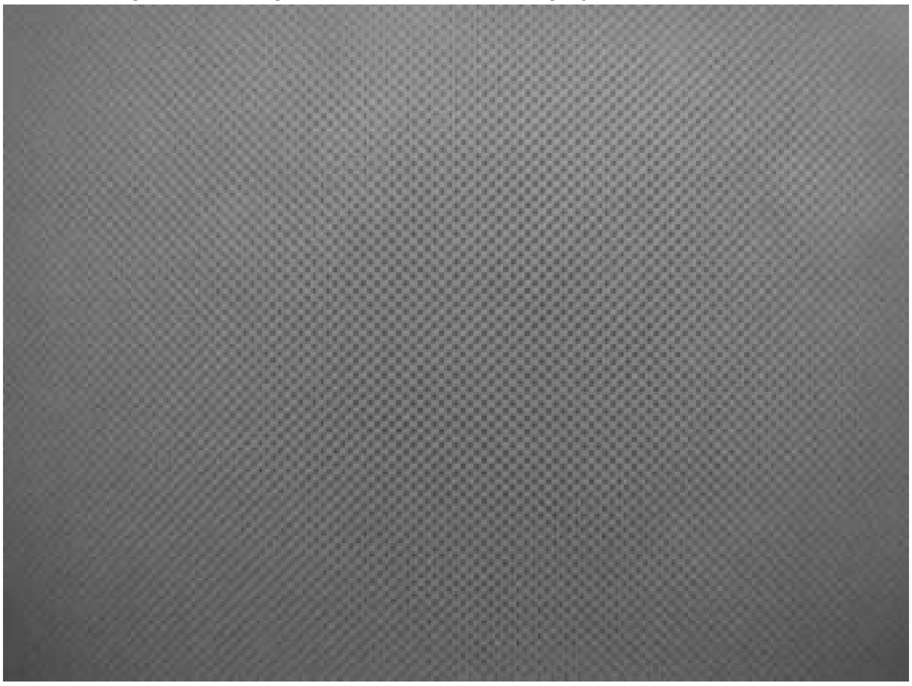


Figure 18: Image taken with badly soiled back window

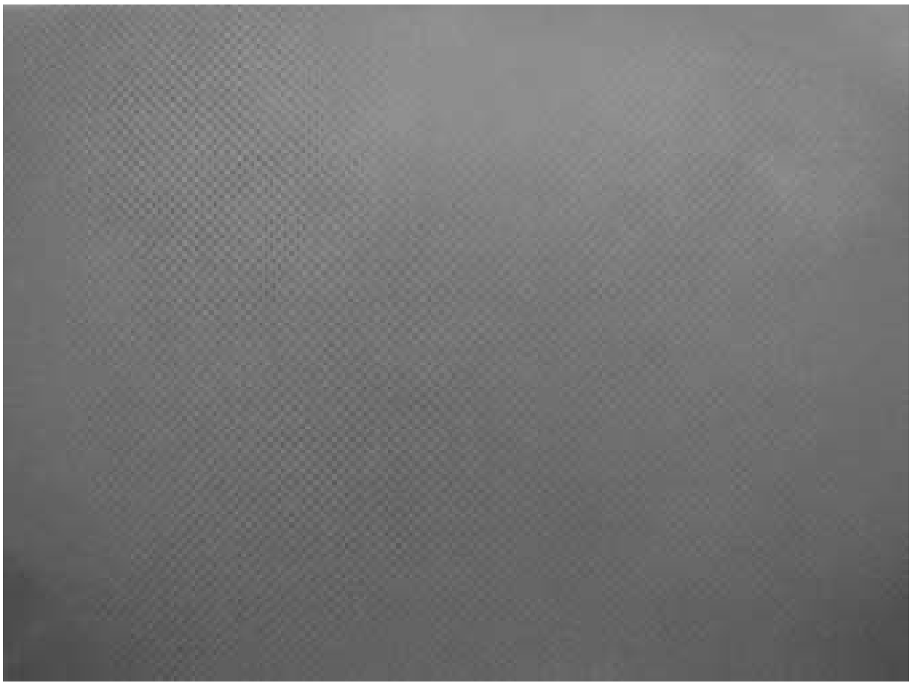


Figure 19: Natural scene, clear back window

Figure 20: Natural scene, badly soiled back window

## Bit errors

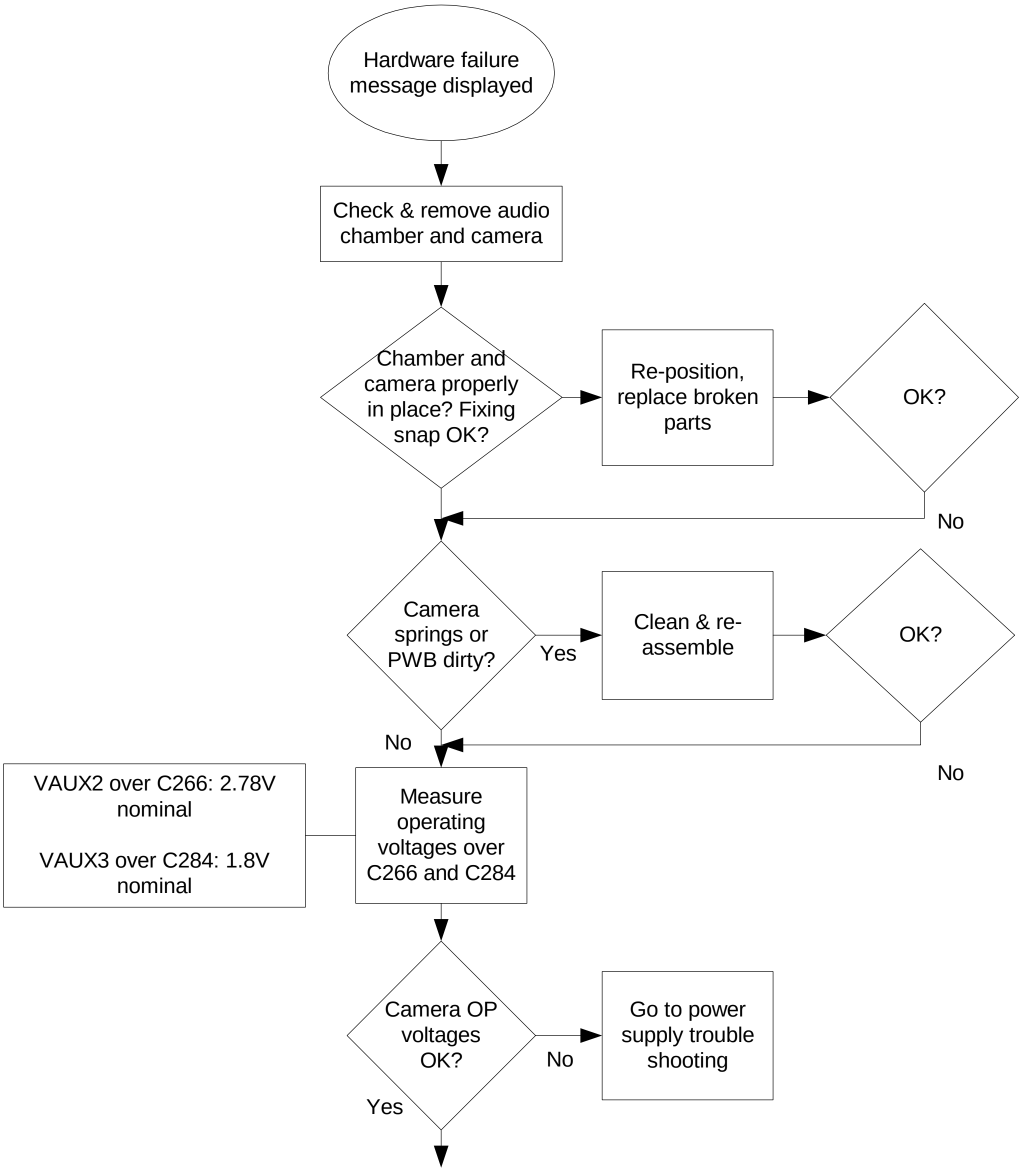
Bit errors are defects in image caused by data transmission error between camera and phone baseband. This type of error is expected to be rare since usually missing bits will cause a hardware failure message. Bit errors can be typically seen in images taken of any object, and they should be most visible in full VGA resolution images. Viewfinder images may not contain the errors at all due to lower bit rate used in this mode. A good practice is to use uniform white test target.

The errors will be clearly visible as colorful sharp dots or lines in camera VGA images.

Typically this is a contact problem between the camera module and LG4. Check camera assembly and spring connector contacts.

# Fault finding trees

## Hardware failure message




(Continued on next page)

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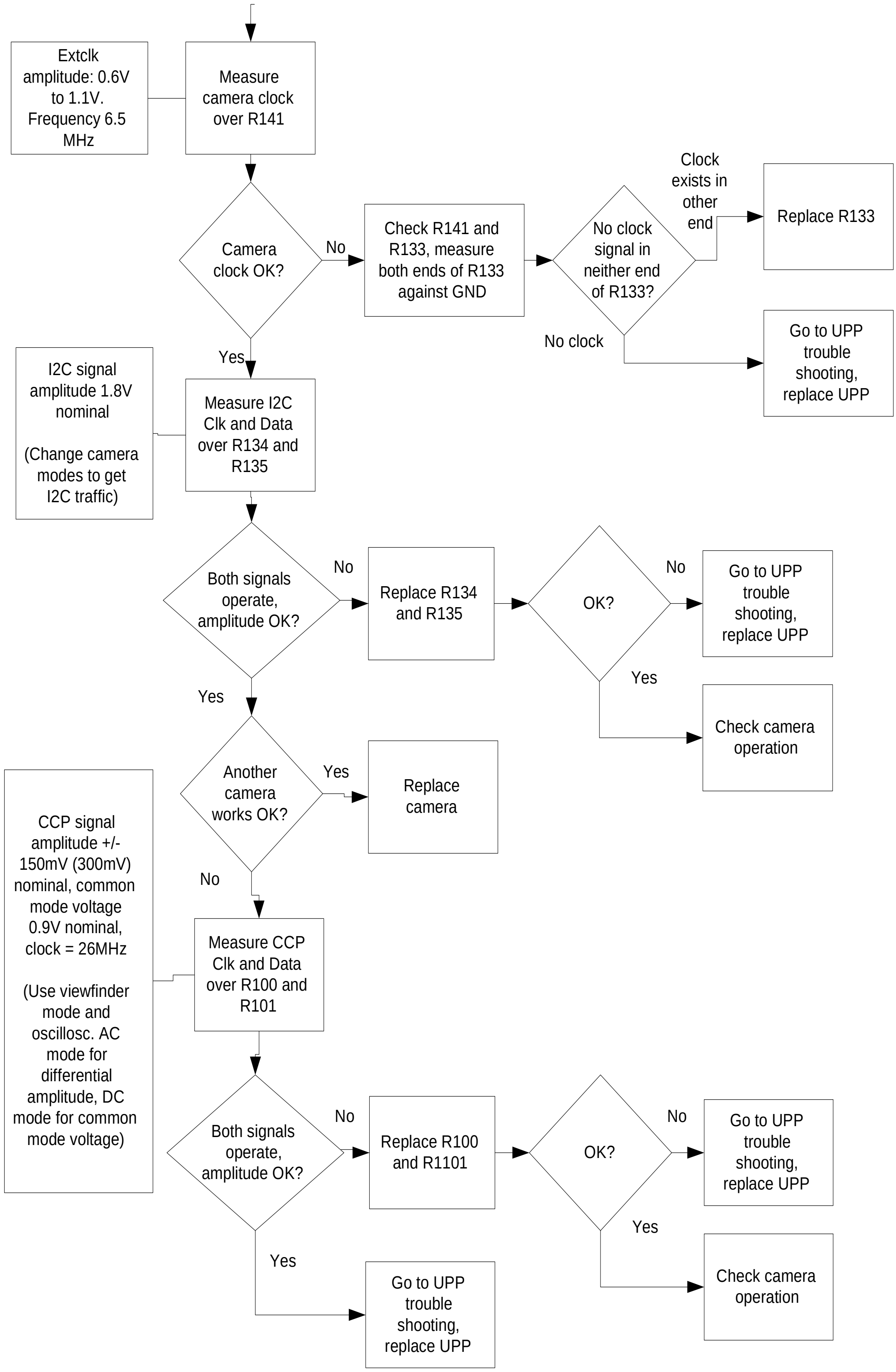
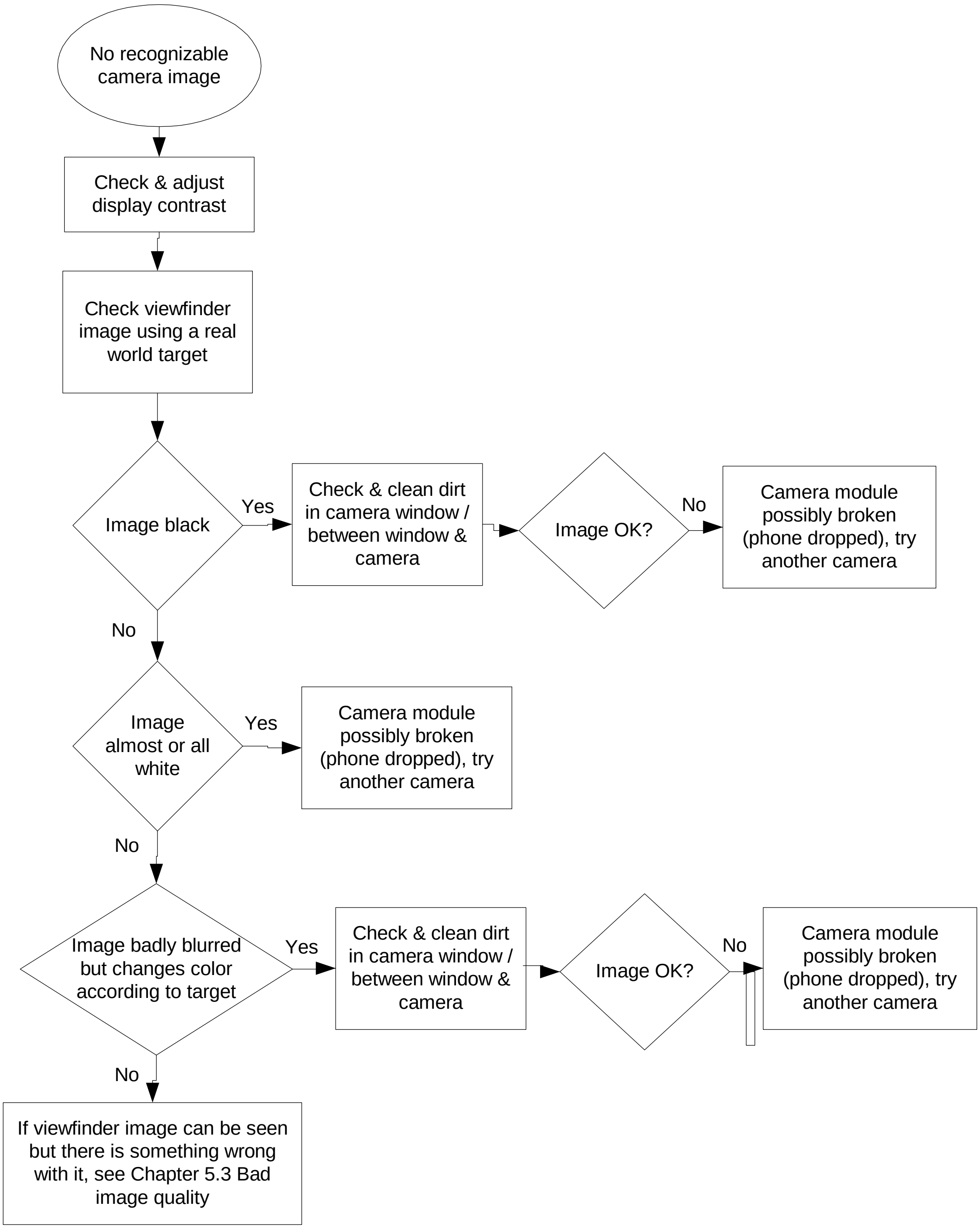
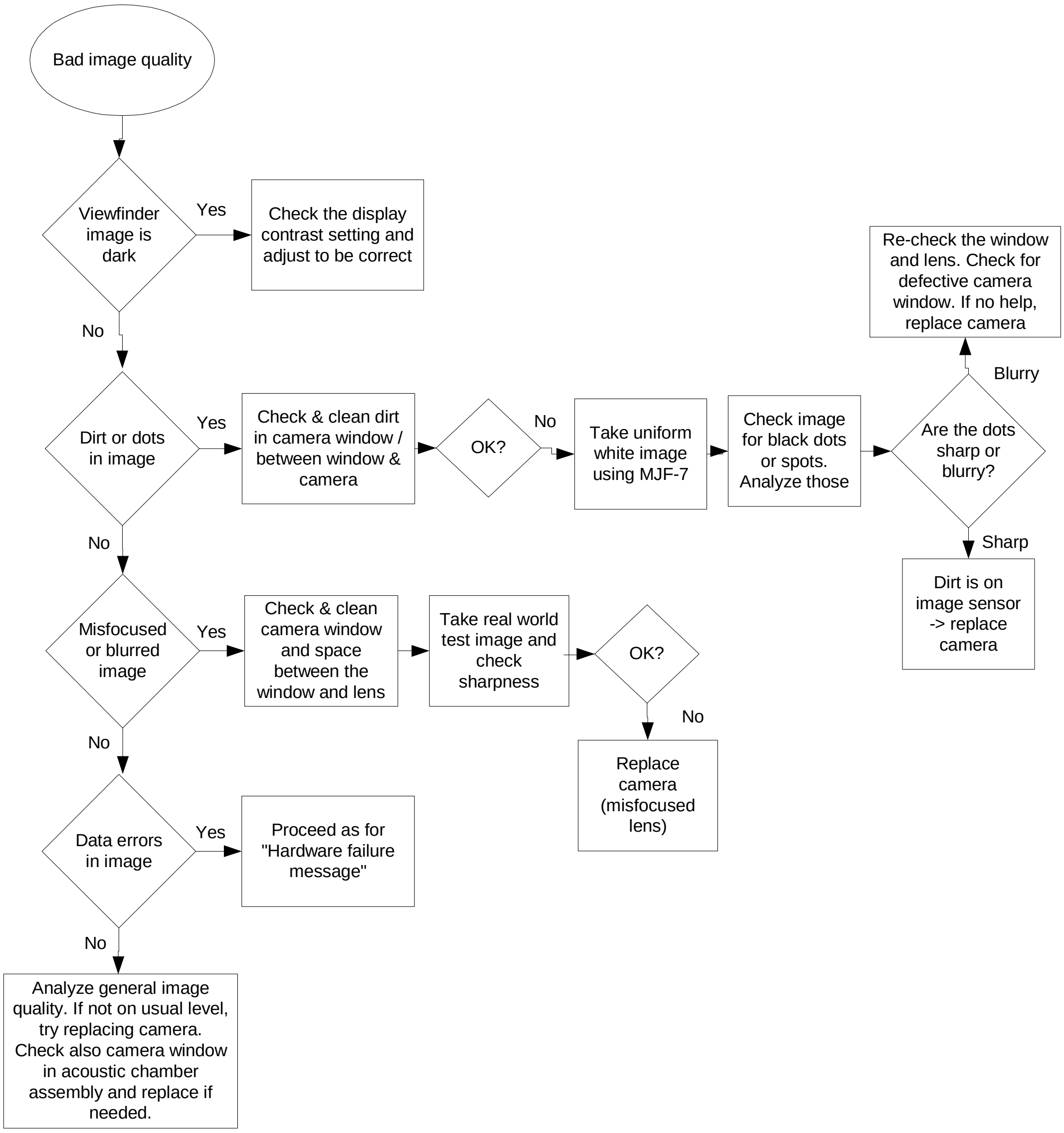


## No recognizable viewfinder image



## Bad image quality



# Accessories

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## Table of Contents

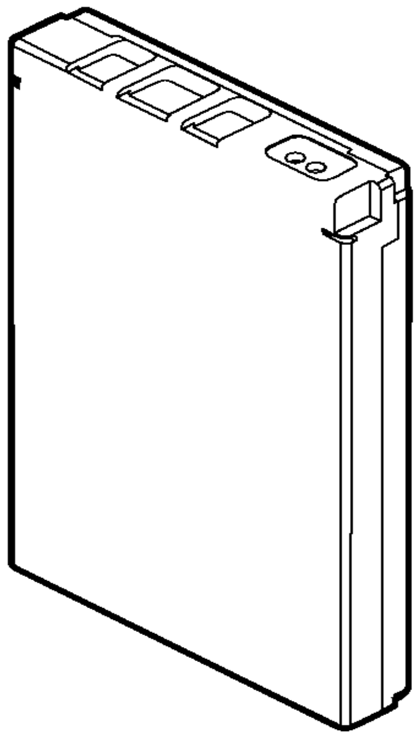
# BLB-2 Standard Battery

The BLB-2 is a Li-ion battery in white plastic package.

## Product Code

BLB-2 Battery pack: *0271570*

**Figure 1: BLB-2**

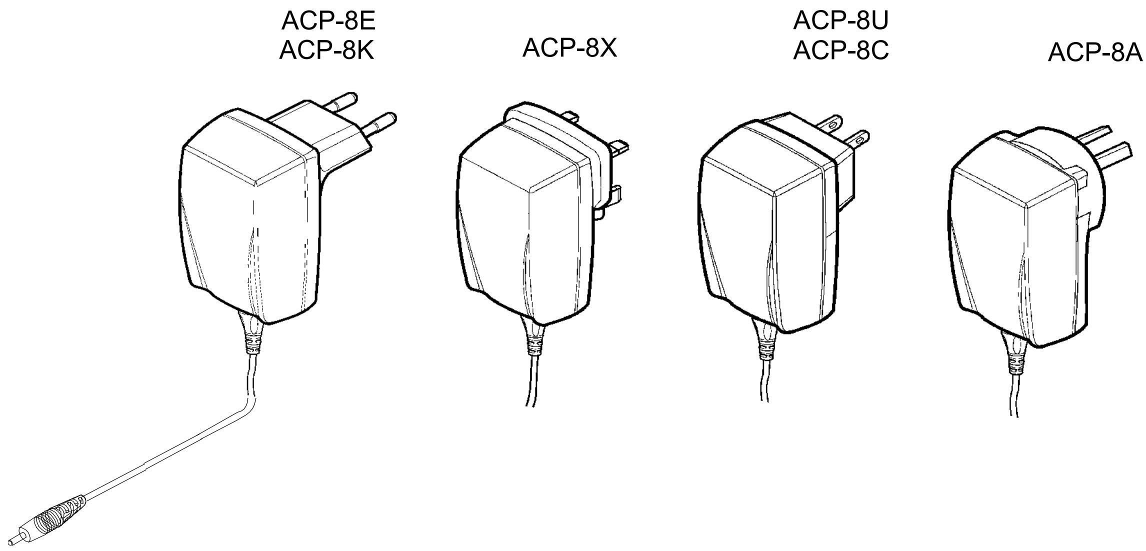


# ACP-8 Travel Charger

Operating within the voltage range 90 V...264 V AC (50 Hz...60 Hz), the Travel Charger is practically current independent in normal office and household use. Like the standard charger, it is compatible with all battery options and is available for different wall sockets.

The Travel Charger can also be used with desktop stand.

**Figure 2: ACP-8**




## Product Variants and Codes

| | | |
|---|---|---|
| ACP-8E | Travel Charger Euro plug 90-264 Vac | *0272169* |
| ACP-8K | Travel Charger Korea plug 90-264 Vac | *0273111* |
| ACP-8X | Travel Charger UK plug 90-264 Vac | *0272172* |
| ACP-8U | Travel Charger US plug 90-264 Vac | *0675196* |
| ACP-8C | Travel Charger China plug 90-264 Vac | *0675211* |
| ACP-8A | Travel Charger Australia plug 90-264 Vac | *0271637* |

## Specification

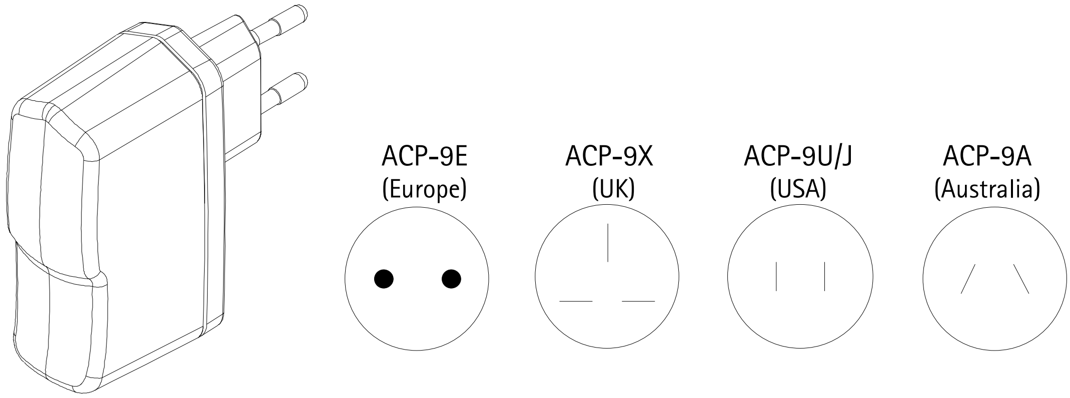
Output connectors: 3.5 mm DC plug, 2-pole (+, -, control)

Protection: Output fault voltage 16 V max.

Output voltage/current (typ): 6.0 V (+0.3 V)/ 620 mA

# ACP-9 Charger

**Figure 3: ACP-9**




## Product Codes

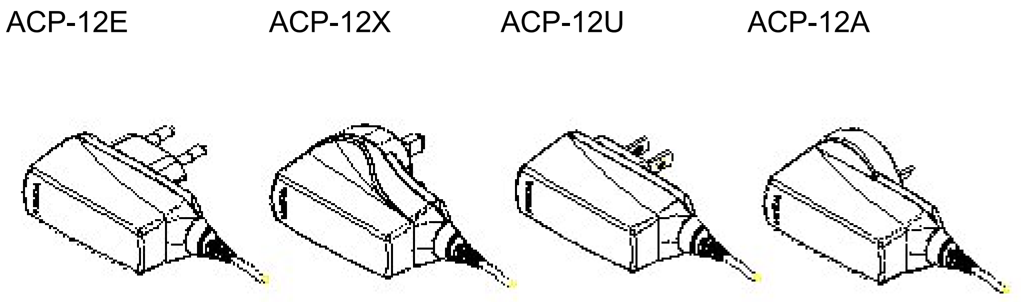
| | |
|---|---|
| ACP-9E | *0675149* |
| ACP-9X | *0675150* |
| ACP-9XU | *0675151* |
| ACP-9J | *0675153* |
| ACP-9A | *0675152* |

# ACP-12 Charger

## Product Codes

| | | |
|---|---|---|
| Travel Charger Europe | ACP-12E | *0675294* |
| TravelCharger UK | ACP-12X | *0675296* |
| Travel Charger USA | ACP-12U | *0675303* |
| Travel Charger Australia | ACP-12A | *0675300* |

**Figure 4: ACP-12**



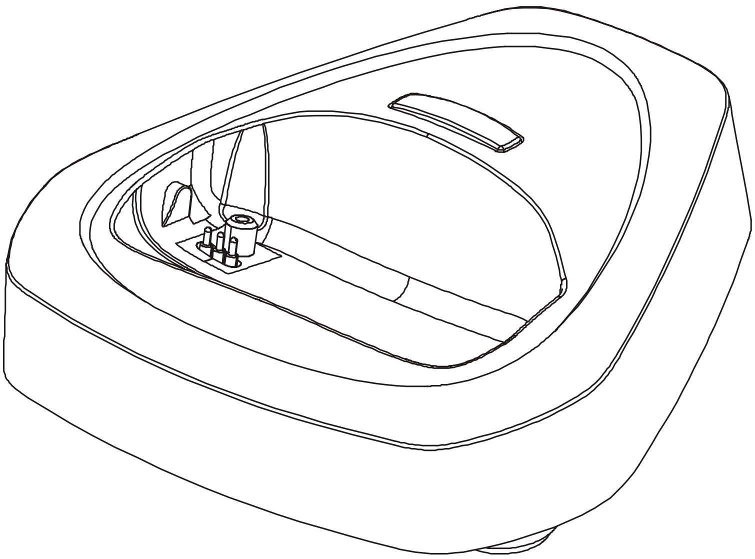
# DCC-1 Desktop Stand

The desktop stand provides charging when connected with a charger.

## Product Code

| | |
|---|---|
| Desktop Stand DCC-1 | *0675288* (universal) |

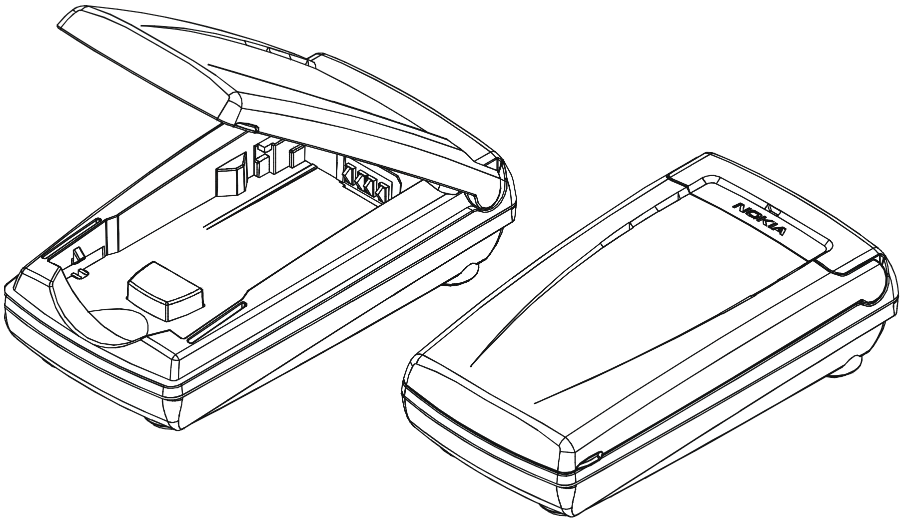
**Figure 5: DCC-1**



# DDC-1 Battery Charging Stand

The Battery Charging Stand provides the possibility to charge a spare battery.

**Figure 6: DDC-1**



## Product Code

DDC-1 Battery Charging Stand: *0272418*

## Specification

Connections: *3.5 mm DC jack (ACP-7, ACP-8, ACP-9 or ACP-12)*

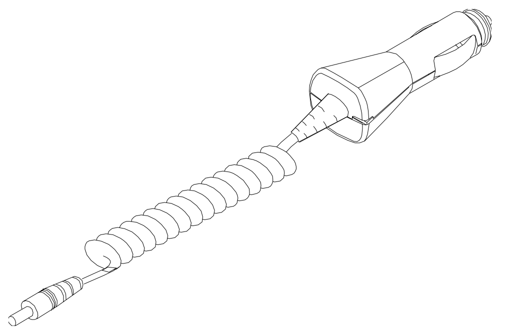
# LCH-9 Mobile Charger

A green light indicates that the cigarette lighter charger is ready for charg ing. Check the charging status on the phone display. The input voltage can be from 11 or 32 V DC, negative grounding.

## Product Code

LCH-9 Mobile Charger: *0675120*

**Figure 7: LCH-9**



## Specification

Connectors
- input: *D 21/23 mm*
- output: *3.5 mm DC plug*

Protection: *input fused, output current limit 850 mA*

Voltage
- input: *11...32 V*
- output (nominal): *8.4 V*

Nominal output current: *800 mA*

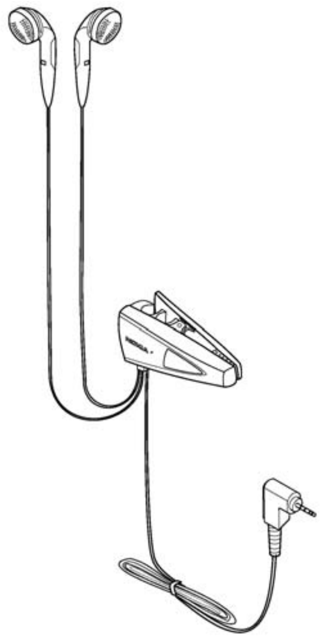
# HDD-1 Headset

The HDD-1 headset provides good audio quality and also has an answer/end button.

## Product Code

| | |
|---|---|
| HDD-1 Headset | *0273302* |

**Figure 8: HDD-1**



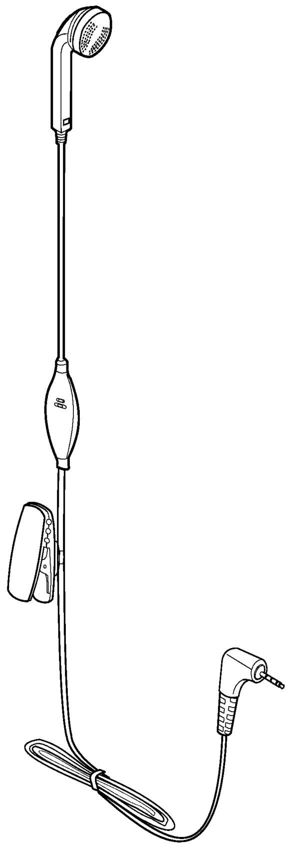
# Headset HDC-5

The HDC-5 headset has an answer/end button.

## Product Code

HDC-5 Headset *0271467*

**Figure 9: HDC-5**



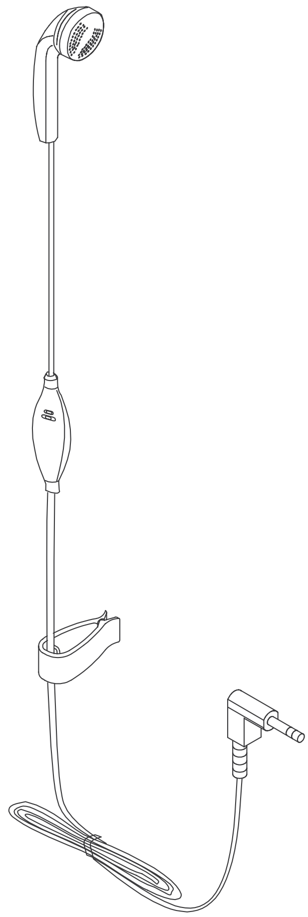
# HDE-2 Headset

The HDE-2 headset provides convenient hands free operation of the phone.

## Product Code

| | |
|---|---|
| Headset HDE-2 | *0694075* |

**Figure 10: HDE-2**



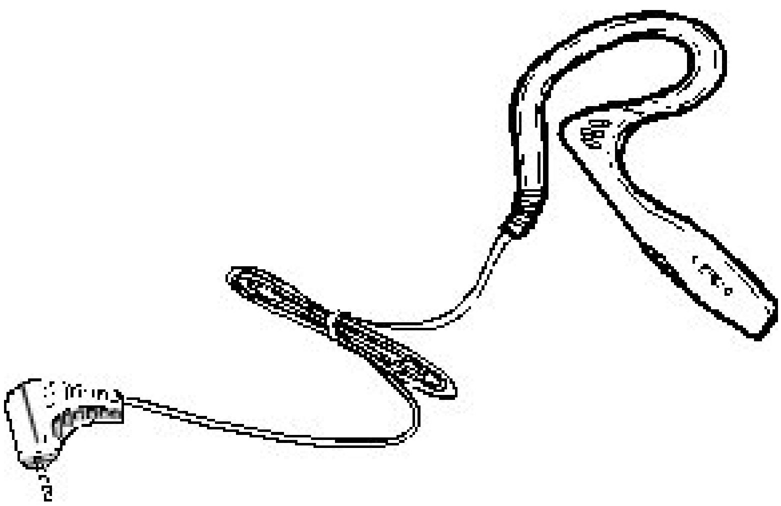
## HDB-5 Boom Headset

The HDB-5 Headset provides you with convenient, portable handsfree.

### Product Code

| | |
|---|---|
| HDB-5 Headset | *0694107* |

**Figure 11: HDB-5**



# Loopset LPS-3

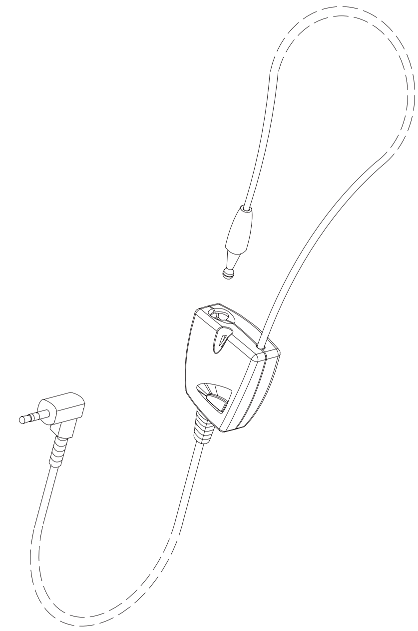
Loopset LPS-3 has been developed for hearing aid users to allow them to use mobile phones. It is based on induction technology.

All hearing aids have support for induction loop, ie. they have a little telecoil inside. This coil can capture the signal supplied to the loop. Standard hearing aids have two operation modes; M-mode for normal microphone use and T-mode for telecoil.

## Product Code

Loopset LPS-3: *0272419*

**Figure 12: LPS-3**



## Recommended Batteries for LPS-3

| Type | Size / IEC-type | Rated capacity | Talk time (3mA load) | Standby (20uA load) |
|---|---|---|---|---|
| Zinc Air Hearing Aid Battery | 675 / PR44 | 540 mAh | 180 hour. | 840 hour or 35 day (1) |
| Silver Oxide Hearing Aid Battery | 675 / SR44 | 150 mAh | 50 hour. | 7 500 hour or 310 day. |
| Alkaline Battery | 675 / LR44 | 110 mAh | 36 hour. | 5 500 hour or 230 day. |

*Note : The capacity of the zinc air battery will fall 20% in a month. After the activation the zinc air battery begins to self-discharge. The battery will be empty within 5 weeks.*

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# Quick Guide

 

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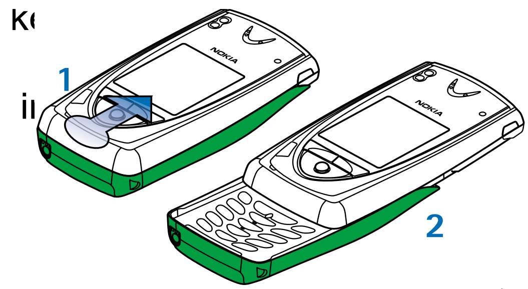
Table of Contents

## Install the SIM card

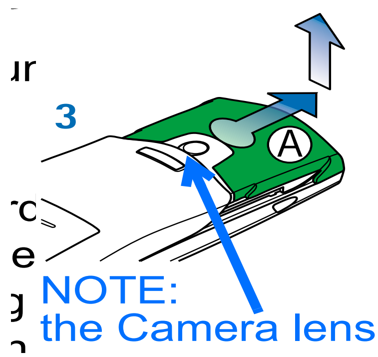
Keep all miniature SIM cards out of the reach of small children.

Before removing the cover(s), always switch off the power and disconnect the phone from the charger or any other device. Always store and use the phone with the covers attached.

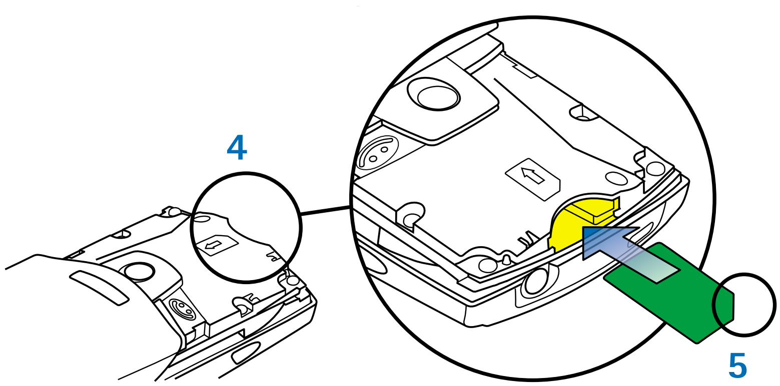
Open the sliding cover: take hold of the back part of the phone and push the phone to open the sliding cover.




Open the A-cover: with the back of the phone facing you, put your thumb in the middle of the cover, slide it forward and then lift it.



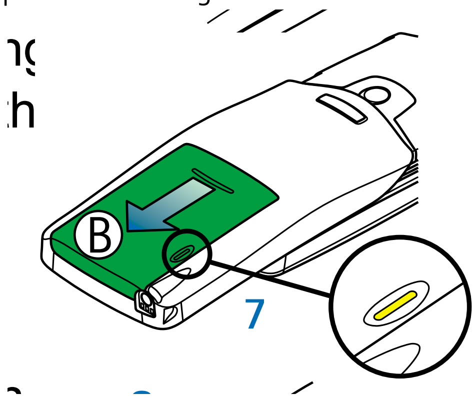

Put the SIM card into the slot, golden contacts down and bevelled corner out ward from the slot.




Replace the A cover: insert the two catches on the sides of the cover into the corresponding slots in the phone and slide the cover until it locks in place.

## Install the battery

Open the B cover: press the locking catch and at the same time slide the cover.




Install the battery: align the contacts with the corresponding connectors of the phone and push the opposite end of the battery until it snaps in place.

Replace the B cover by sliding it back into place.

Charge the battery, the charging contact is at the lower left hand corner of the phone.

## Switching the phone on/off

WARNING! Do not switch on the phone when wireless phone use is prohibited or when it may cause interference or danger.

Press and hold the power key at the top right of the phone.

Key in the first settings (time, date) with the number keys and press OK soft key to accept.

### Normal position

Hold the phone as you would any other telephone with the antenna pointed up and over your shoulder.

### Tips on efficient operation

Your phone has a built-in antenna. As with any other radio transmitting device, do not touch the antenna unnecessarily when the phone is switched on. Contact with the antenna affects call quality and may cause the phone to operate at a higher power level than otherwise needed. Not touching the antenna area during a phone call optimises the antenna performance and the talktime of your phone.

## Joystick

To move the focus on the display, push the joystick to the left, right, up and down. Press the joystick to open an application, to take a picture, to make selections, changes or to confirm an operation.

## Making a call

Open the sliding cover.  in standby mode key in the phone number including the area code.

Press green handset pic key to initiate the call

Press red handset pic key to end the call

Closing the sliding cover ends all voice calls and rejects an incoming call.

## Taking a picture

IMPORTANT: Make sure to obey all laws governing the taking of pictures.  Do not use this feature illegally.

Open the sliding cover  to open the camera lens and press soft key Camera in standby mode.  The Camera application opens and you can see the view to be captured on the display of the phone.

Press the joystick to take a picture.

Press soft key Delete if you do not want to save the photo.  Else the photos are saved automatically in the Images application.

To take another picture press the joystick to return to the viewfinder.

## Keyguard

To lock the keys close the sliding cover and press the soft key Keyguard.  Key icon appears on display.

To unlock the keys open the sliding cover and press the soft key Unlock and then OK.

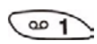
When the keyguard is on, to answer a call, press the green handset pic key.  During a call the phone can be operated in the normal way.  When you end or reject the call, the keypad will be automatically locked.

Note: When Keygard is on, calls may be possible to the emergency number programmed into your phone (e.g. 112 or other official emergency number). Open the sliding keypad and key in the emergency number and press  . The number is displayed only after you have keyed in its last digit.

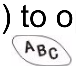
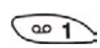
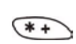
For more information about using the phone kindly refer to the Nokia 7650 phone user's guide.

## NHL-2NA Shortcuts

### Shortcuts in Standby mode

- Press  (Menu key) to open the main Menu.
- Press the joystick to open Contacts.
- Press  to open a list of the last dialled numbers. Move the joystick to the left to view received and missed calls lists.
- To change the profile, press  (power key) briefly and select the profile.
- Press and hold  (voice key) to start voice dialling. See p.43 in the User's Guide.
- Press  and  to call your voice mailbox. See p. 17 in the User's Guide.

### Shortcuts in editors

- Press  (Edit key) to open a list of commands related to writing and editing text. Press  to switch between predictive, traditional text input and number mode (*Dictionary -> Dictionary on, Alpha mode, Number mode*)
- When you are writing, press  repeatedly to access different kinds of special characters, or press  to open a list of special characters. Press  to enter a space.
- You can also use  to mark items. Press and hold  and at the same time, move the joystick to mark text to be copied or erased.

### Other shortcuts

- When you have an active phone call, press  (voice key) briefly to change to loudspeaker mode. See p. 13 in the User's Guide.
- In the main Menu, press and hold  (Menu key) to open a view where you can see all the applications that are open and switch between them. See also p. 9 in the User's Guide.

## NHL-2NA Keys and parts

**Infrared port**

**Headset connector**

**Voice key**, see p. 13 and 43 in the User's Guide.

**Proximity sensor**, see p. 13 in the User's Guide.

**Left and right selection keys**

**Menu key**

- Opens the main Menu, a list of applications. See also p. 9 in the User's guide.

**Microphone**

**Edit key**

- Opens a list of commands for text editing, see p. 63 in the User's Guide.


Battery connector

**Loudspeaker**

**Earpiece**

**Power key**

**Light sensor**, see p. 27 in the User's Guide.

**Joystick**

- To move to the left and right, up, and down.
- Press to activate or select.

**Call key**

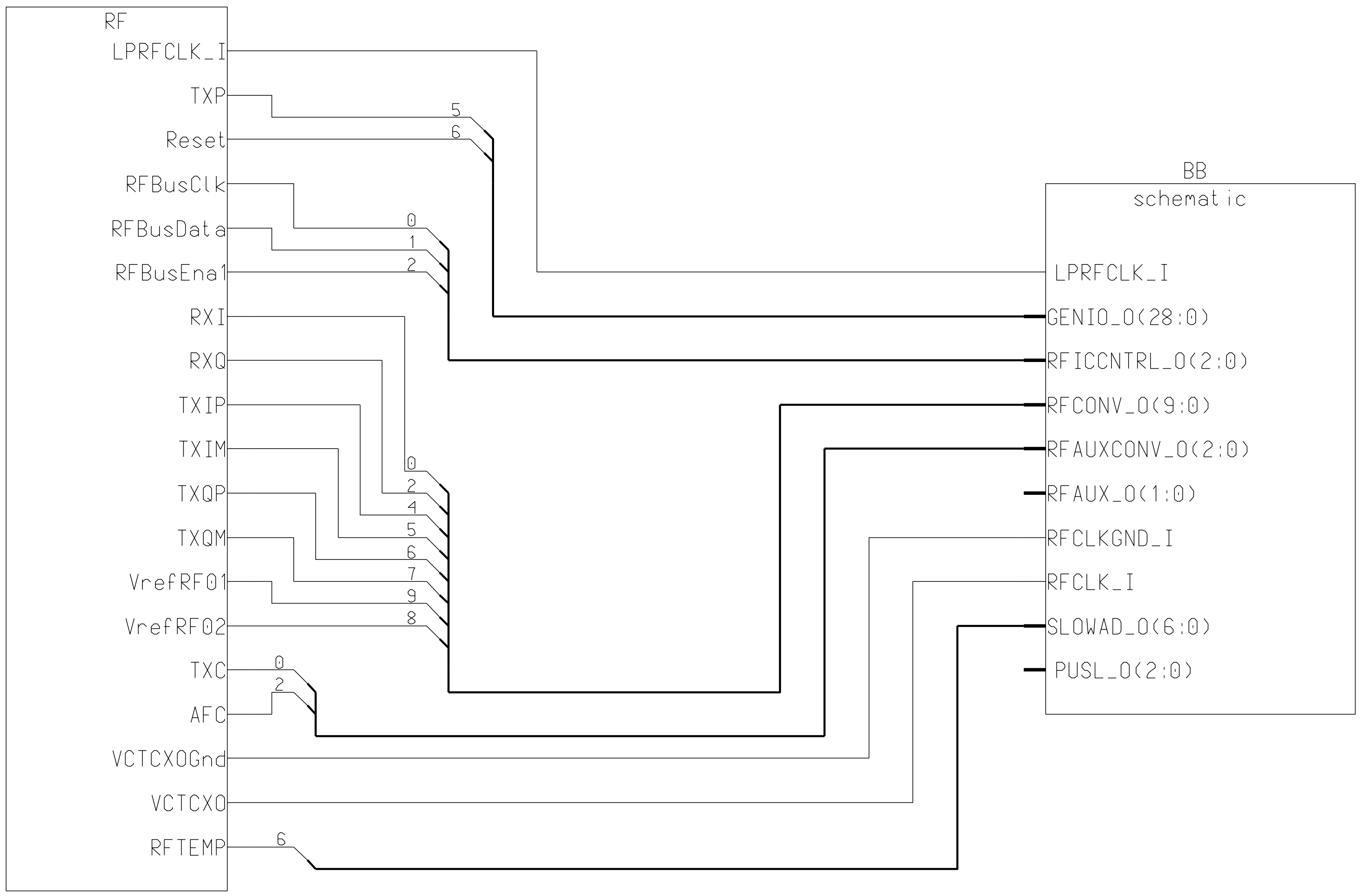
**Clear key**

- Use to clear an entry or to delete an item.

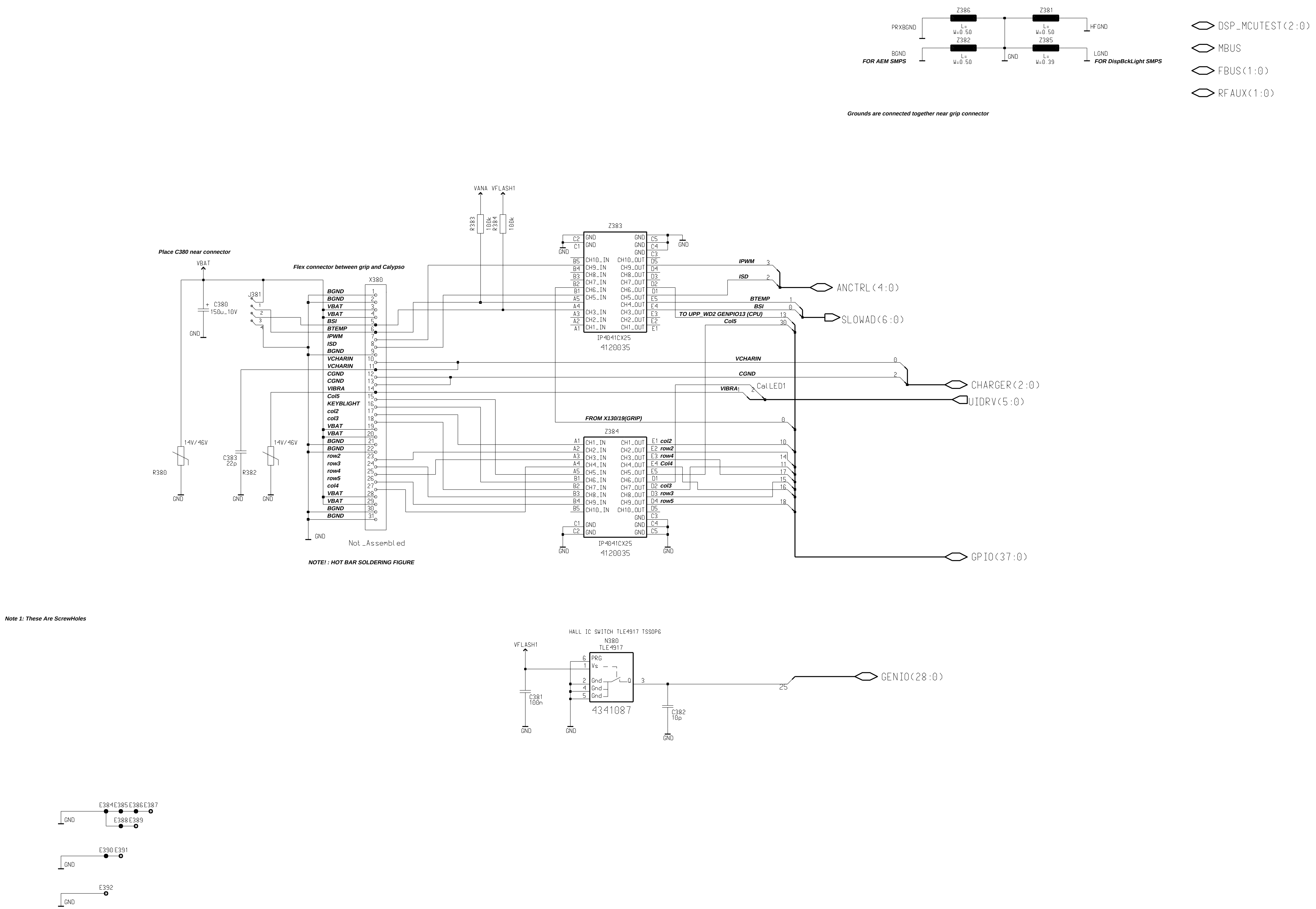
**End key**, EXIT to standby mode

**RF-BB connection diagram**

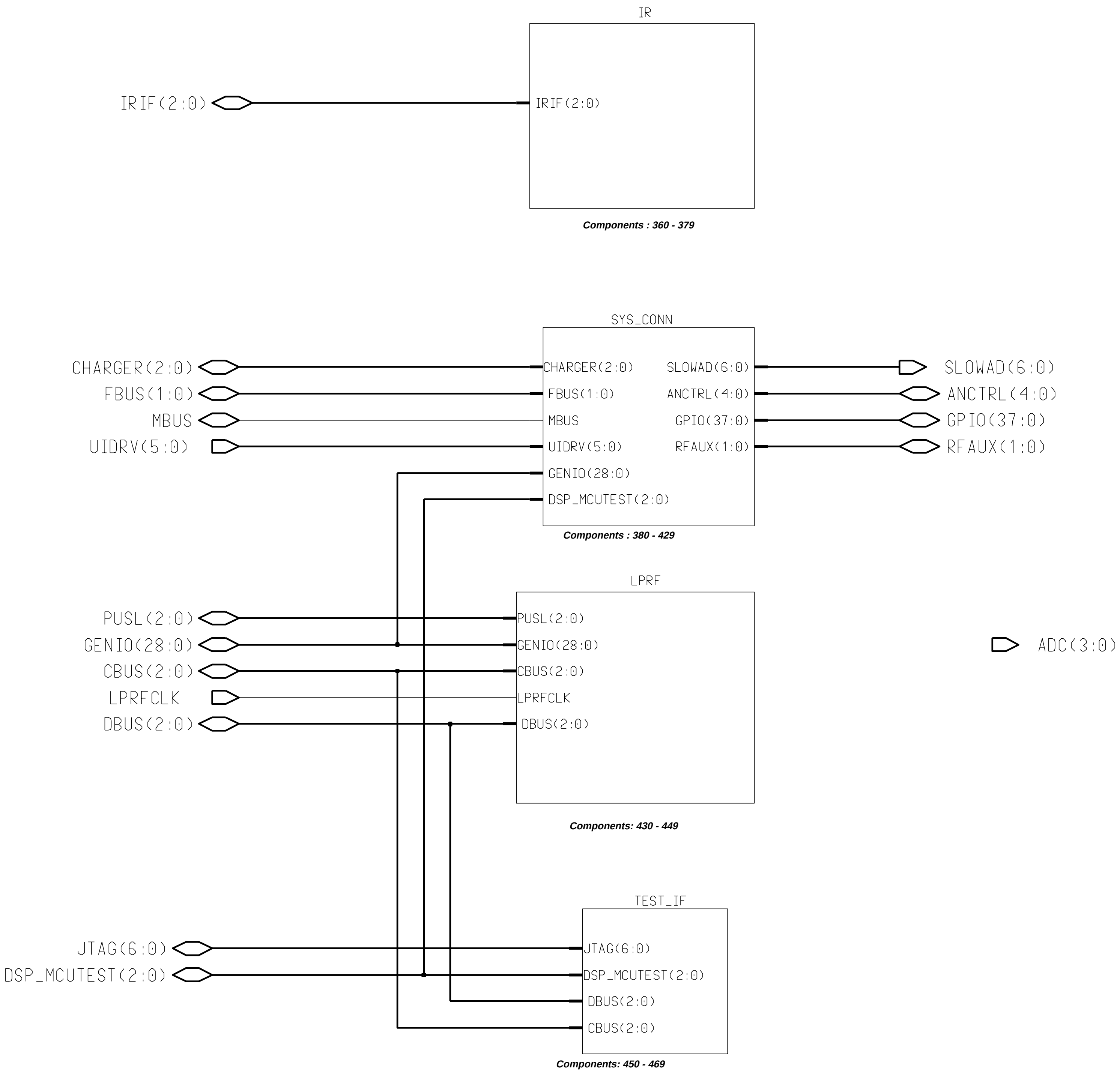
| GLOBAL SYMBOLS | |
|---|---|
| VR1A | |
| VR2 | |
| VR3 | |
| VR4 | |
| VR5 | |
| VR6 | |
| VR7 | |
| VBAT | |
| IPA1 | Not used |
| IPA2 | Not used |



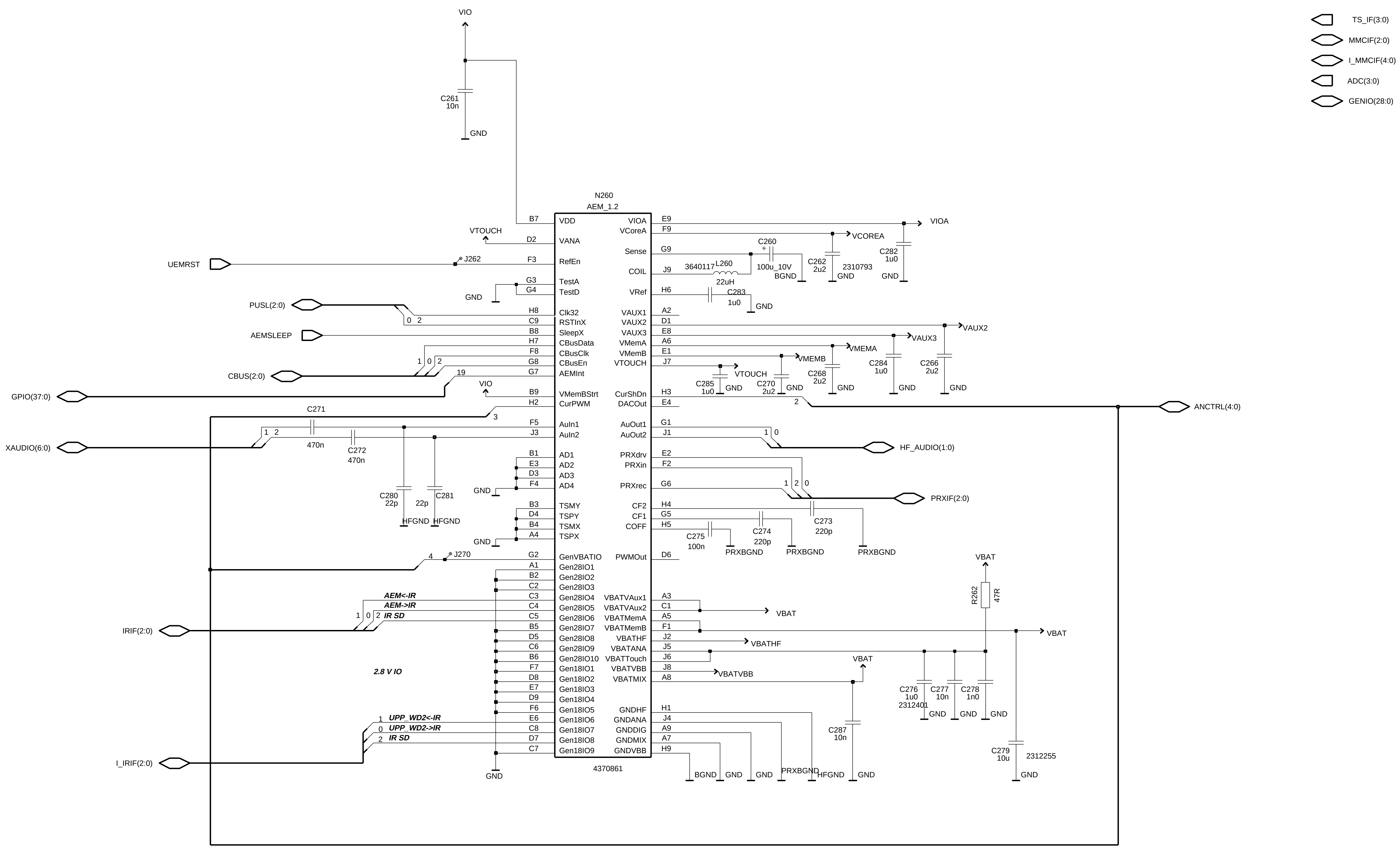
**System Connector Diagram**



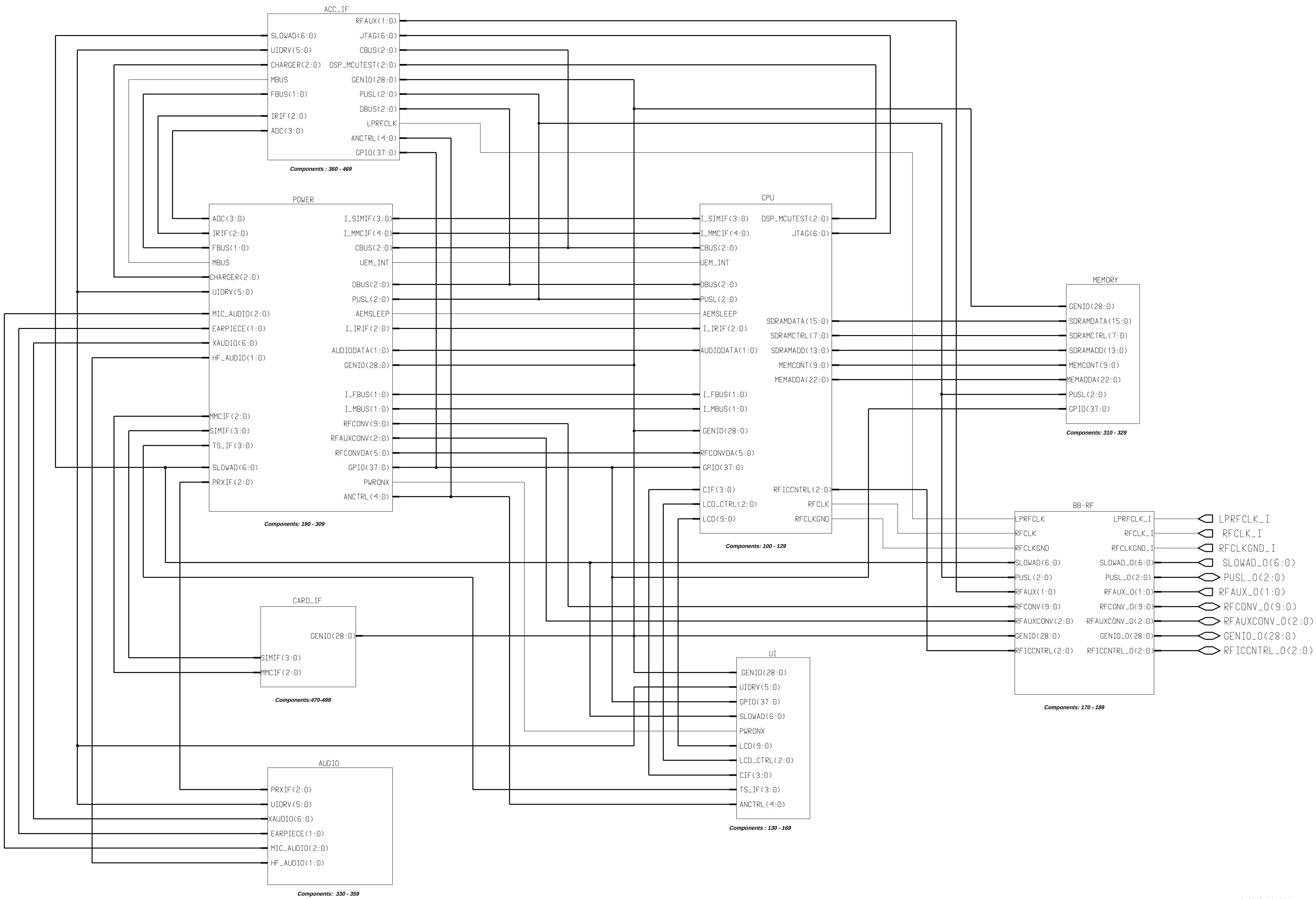
**Accessories interface diagaram**



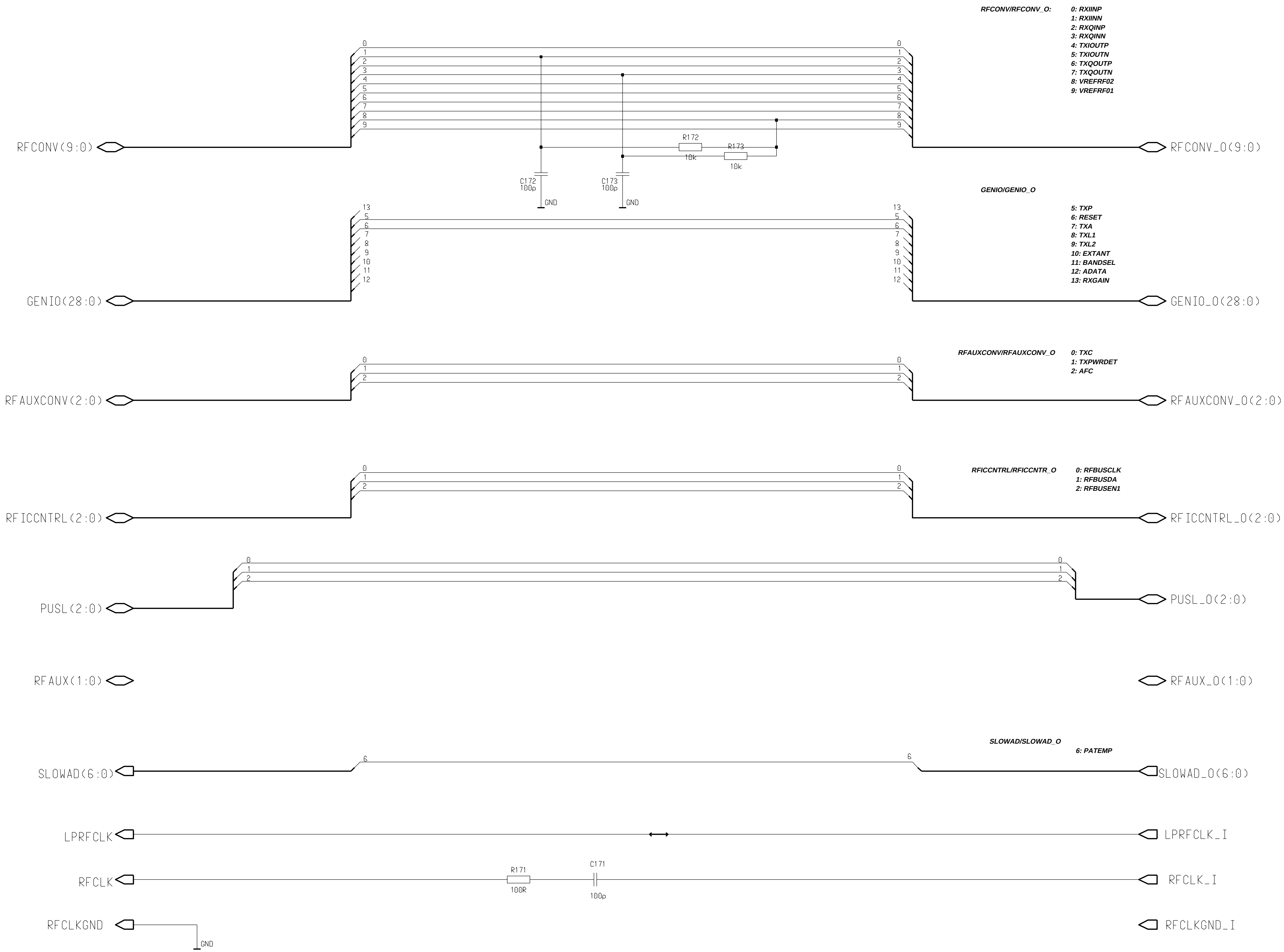
## AEM diagram


VIO
C261
10n
GND
TS_IF(3:0)
MMCIF(2:0)
I_MMCIF(4:0)
ADC(3:0)
GENIO(28:0)
N260
AEM_1.2
VTOUCH
UEMRST
J262
PUSL(2:0)
AEMSLEEP
CBUS(2:0)
GPIO(37:0)
XAUDIO(6:0)
C271
470n
C272
470n
C280
22p
C281
22p
HFGND
J270
IRIF(2:0)
I_IRIF(2:0)
AEM<-IR
AEM->IR
IR SD
UPP_WD2<-IR
UPP_WD2->IR
2.8 V IO
VDD
VANA
RefEn
TestA
TestD
Clk32
RSTInX
SleepX
CBusData
CBusClk
CBusEn
AEMInt
VMemBStrt
CurPWM
AuIn1
AuIn2
AD1
AD2
AD3
AD4
TSMY
TSPY
TSMX
TSPX
GenVBATIO
Gen28IO1
Gen28IO2
Gen28IO3
Gen28IO4
Gen28IO5
Gen28IO6
Gen28IO7
Gen28IO8
Gen28IO9
Gen28IO10
Gen18IO1
Gen18IO2
Gen18IO3
Gen18IO4
Gen18IO5
Gen18IO6
Gen18IO7
Gen18IO8
Gen18IO9
VIOA
VCoreA
Sense
COIL
VRef
VAUX1
VAUX2
VAUX3
VMemA
VMemB
CurShDn
DACOut
AuOut1
AuOut2
PRXdrv
PRXin
PRXrec
CF2
CF1
COFF
PWMOut
VBATVAux1
VBATVAux2
VBATMemA
VBATMemB
VBATHF
VBATANA
VBATTouch
VBATVBB
VBATMIX
GNDHF
GNDANA
GNDDIG
GNDMIX
GNDVBB
4370861
VCOREA
C260
100u_10V
BGND
C262
2u2
2310793
C282
1u0
3640117
L260
22uH
C283
1u0
VAUX2
VAUX3
VMEMA
VMEMB
C285
1u0
C270
2u2
C268
2u2
C284
1u0
C266
2u2
ANCTRL(4:0)
HF_AUDIO(1:0)
PRXIF(2:0)
C273
220p
C274
220p
C275
100n
PRXBGND
VBAT
R262
47R
VBATHF
VBATVBB
C276
1u0
2312401
C277
10n
C278
1n0
C287
10n
C279
10u
2312255

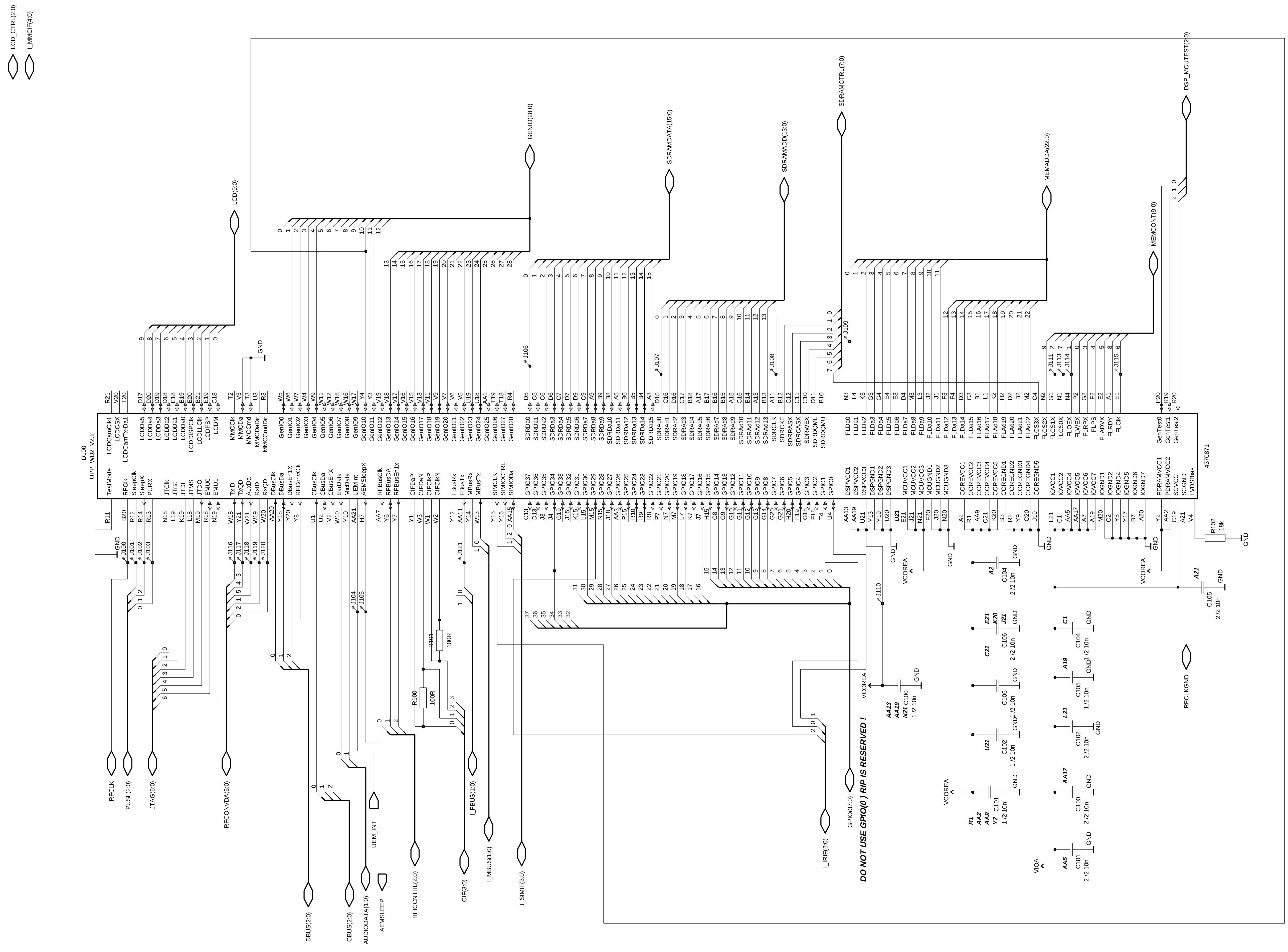
**Baseband Diagram**



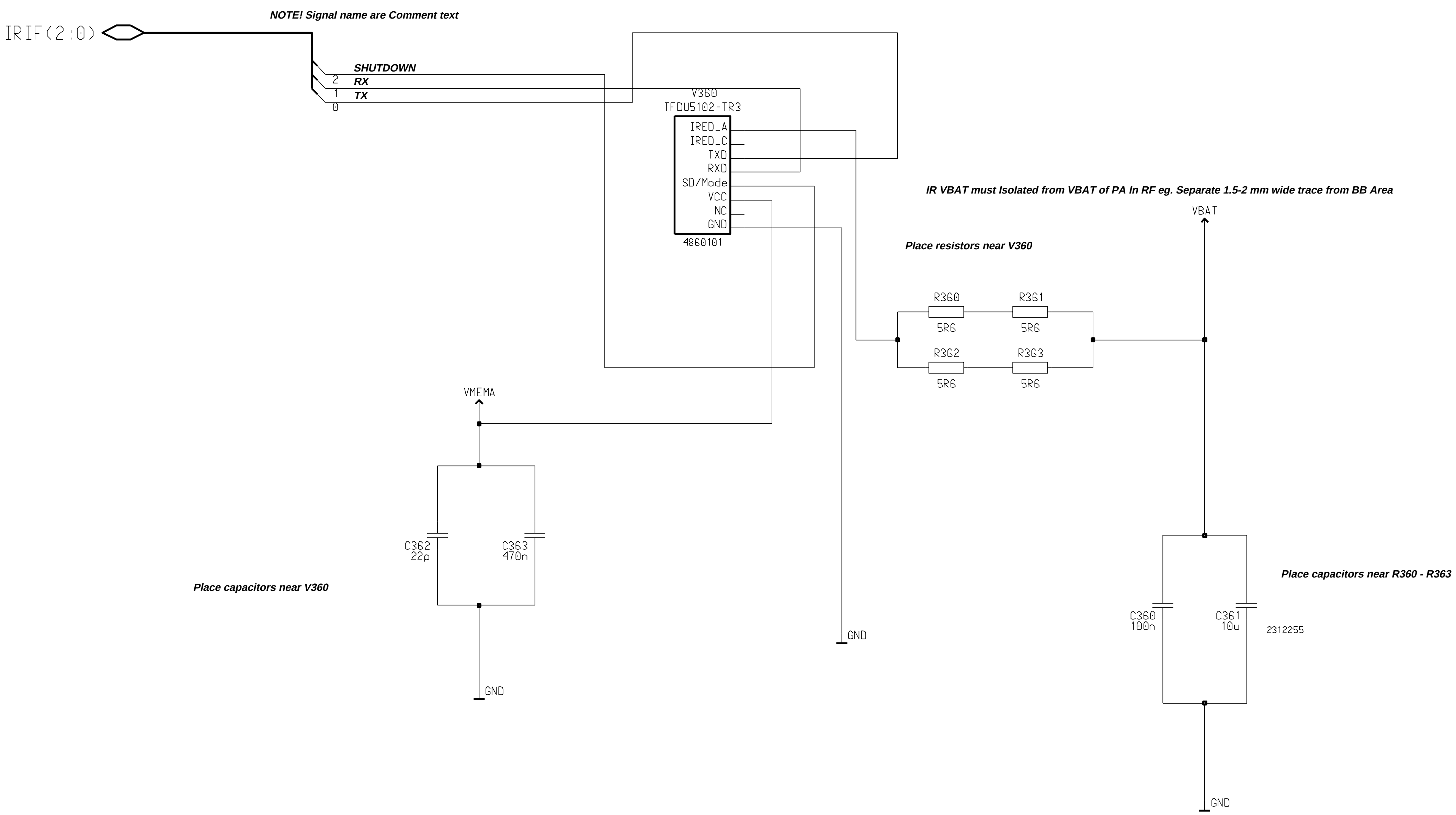
**BB-RF Interface diagram**



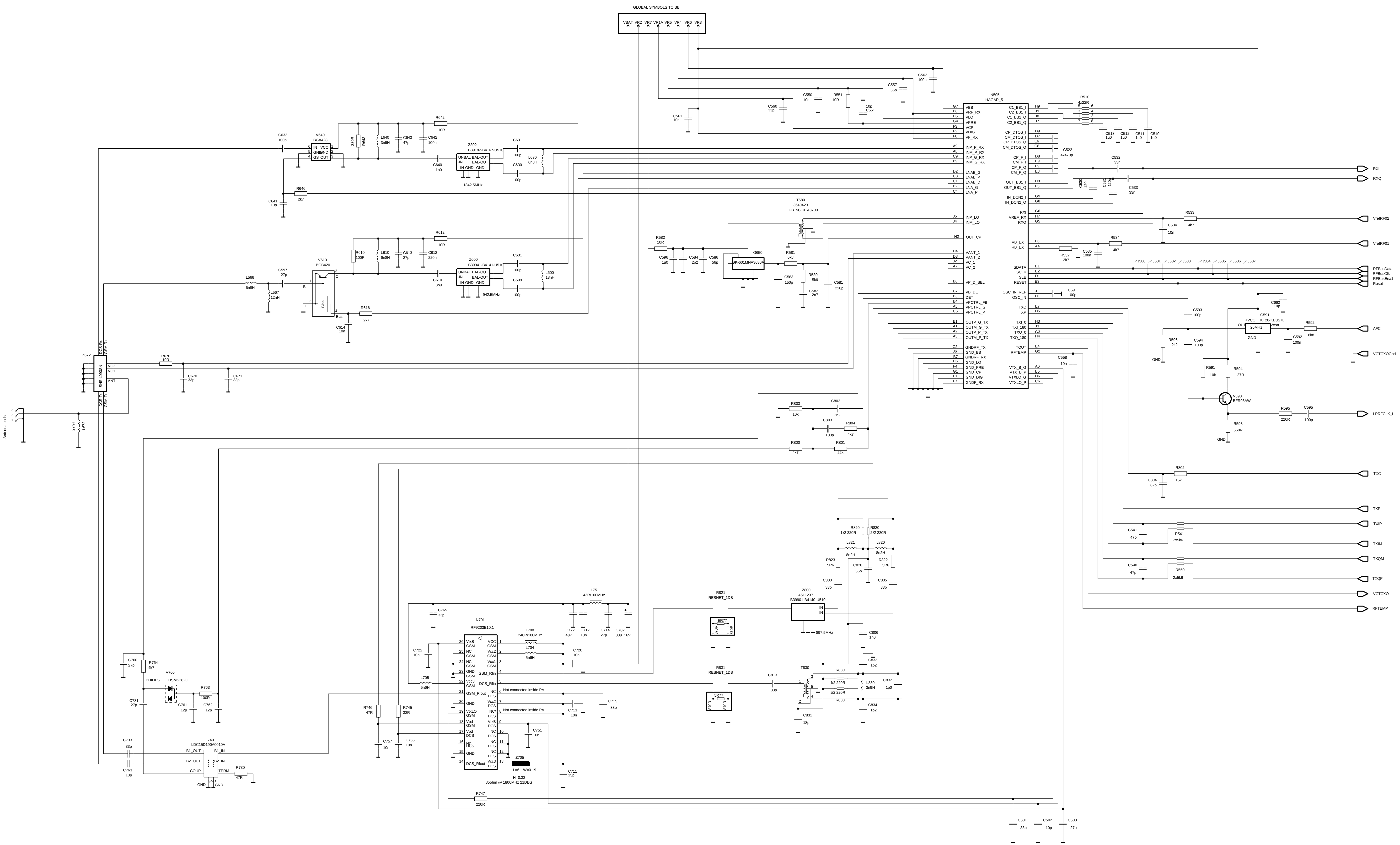
## CPU Diagram


LCD_CTRL(2:0)
I_MMCIF(4:0)
LCD(9:0)
GENIO(28:0)
SDRAMDATA(15:0)
SDRAMADD(13:0)
SDRAMCTRL(7:0)
MEMADDA(22:0)
MEMCONT(9:0)
DSP_MCUTEST(2:0)
D100
UPP_WD2_V2.2
4370871
RFCLK
PUSL(2:0)
JTAG(6:0)
RFCONVDA(5:0)
DBUS(2:0)
CBUS(2:0)
AUDIODATA(1:0)
AEMSLEEP
UEM_INT
RFICCNTRL(2:0)
CIF(3:0)
I_FBUS(1:0)
I_MBUS(1:0)
I_SIMIF(3:0)
I_IRIF(2:0)
GPIO(37:0)
DO NOT USE GPIO(0) RIP IS RESERVED !
VCOREA
VIOA
RFCLKGND
R100 100R
R101 100R
R102 18k

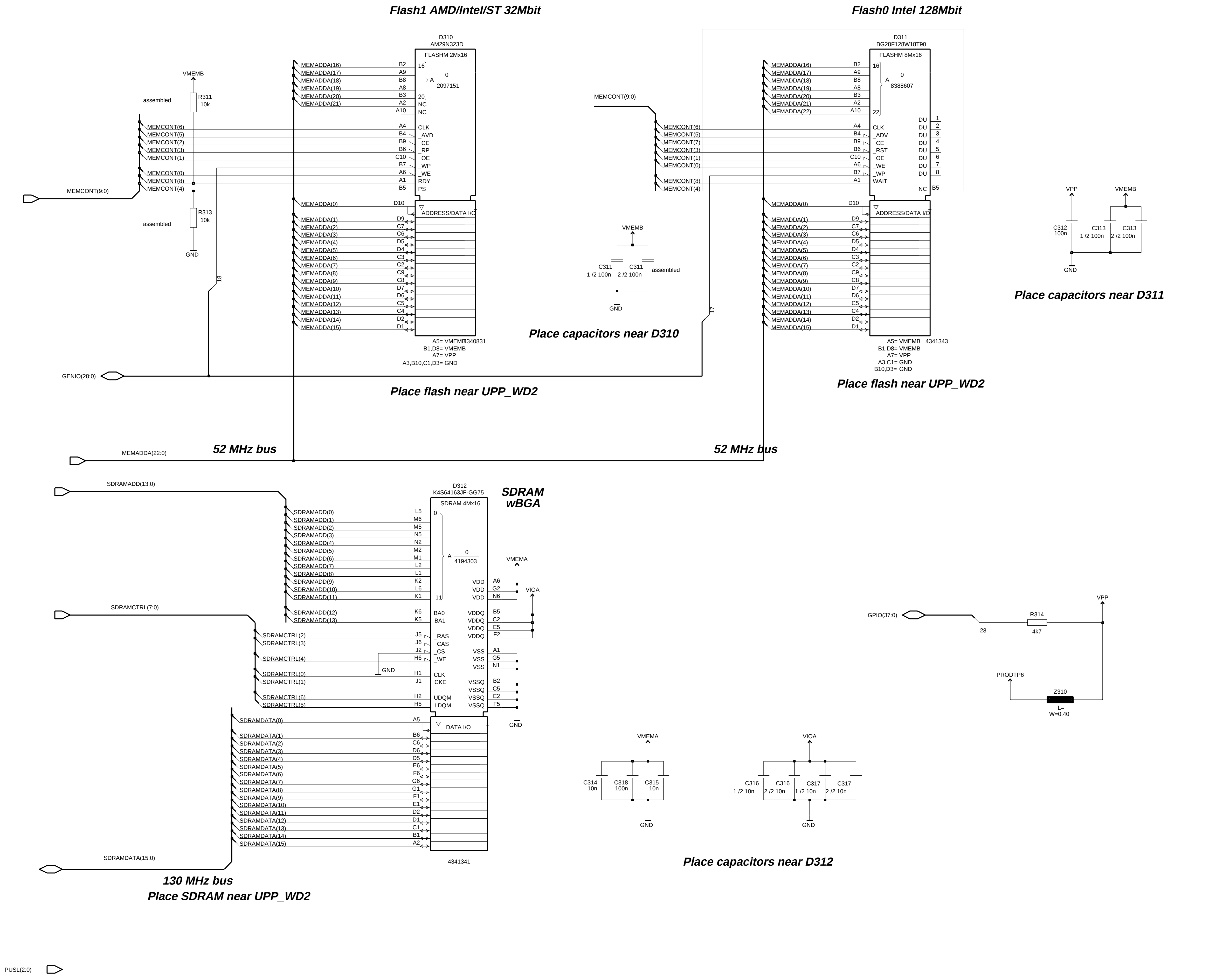
**IR module diagram**



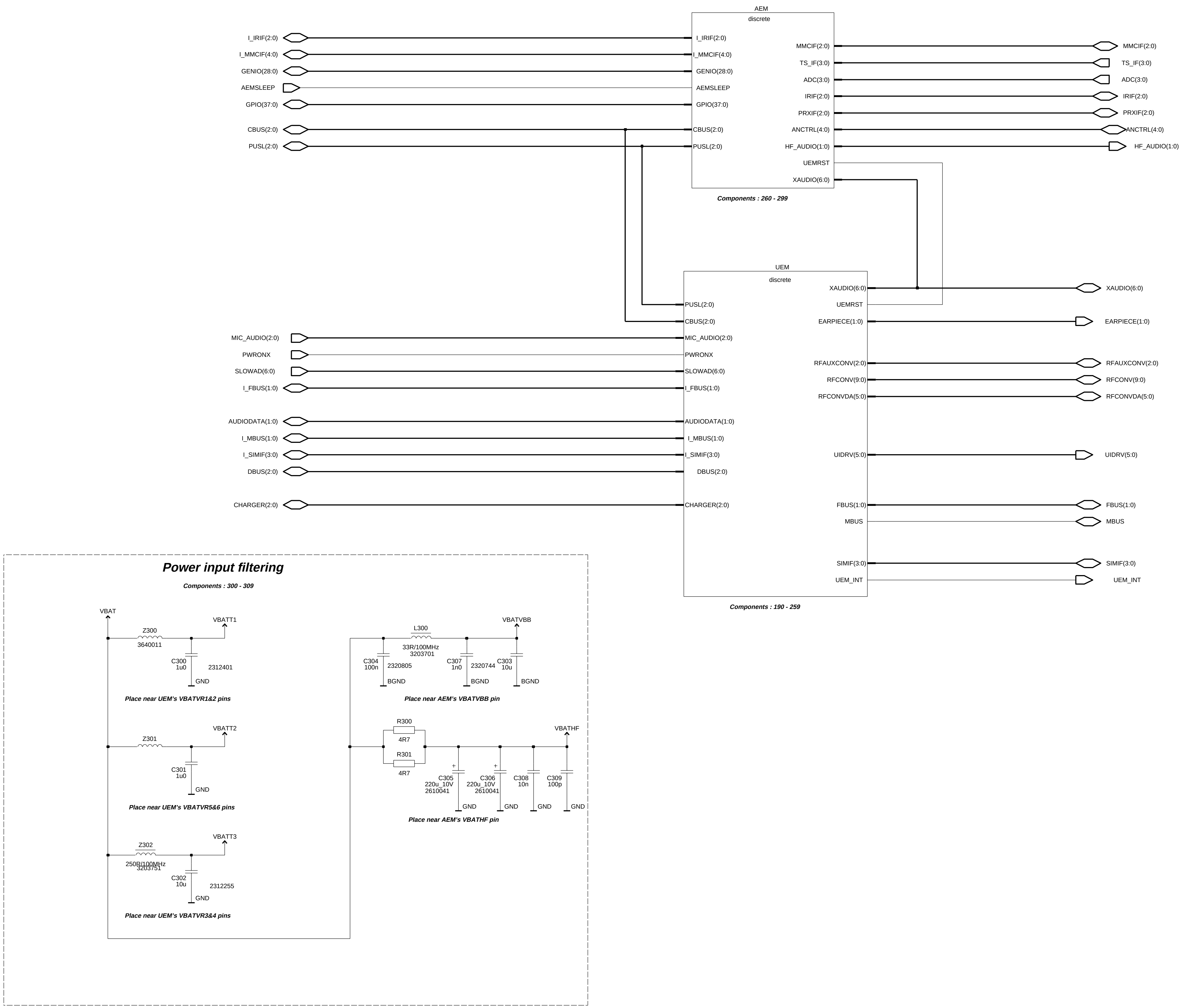
**RF diagram**



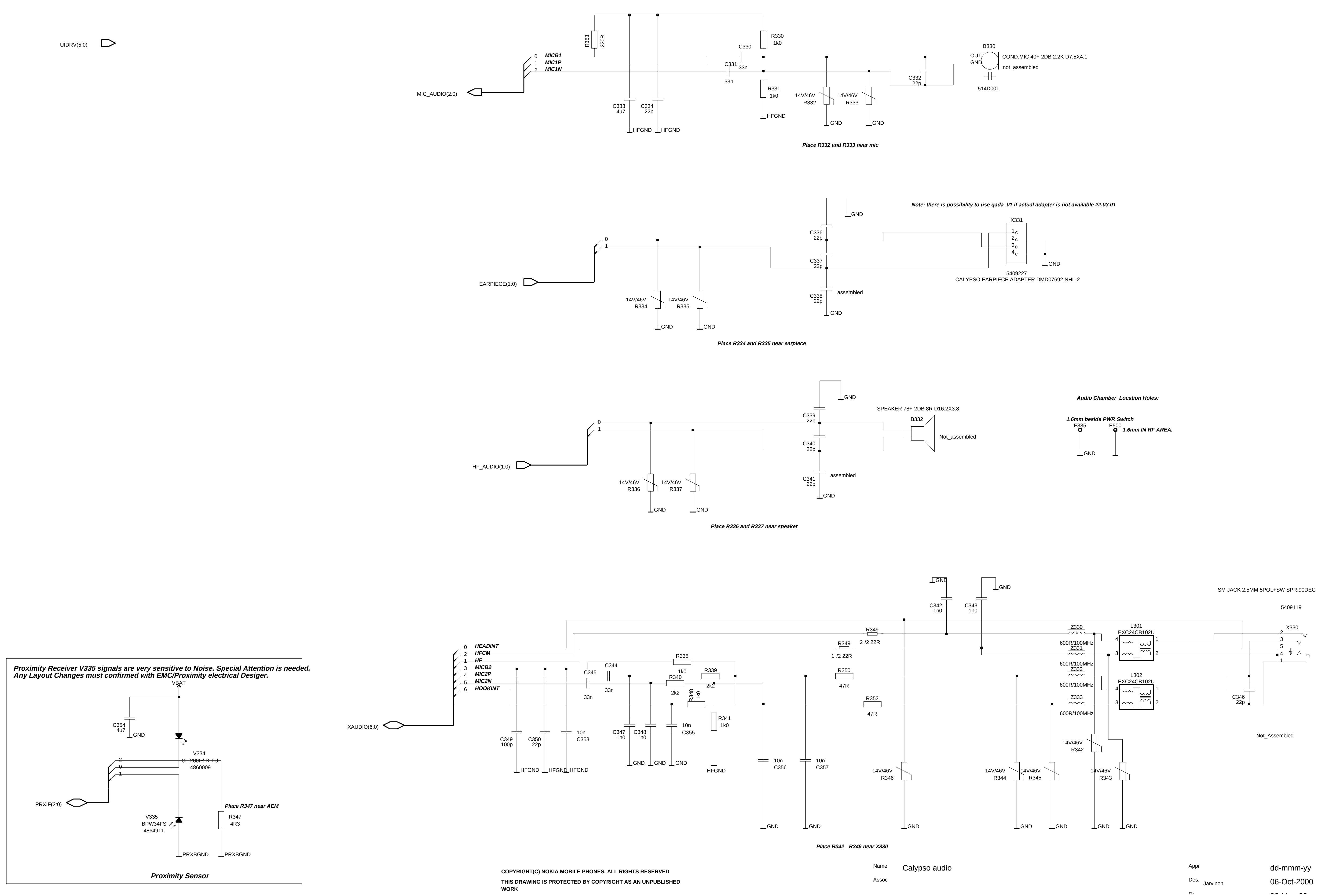
## Memories diagram



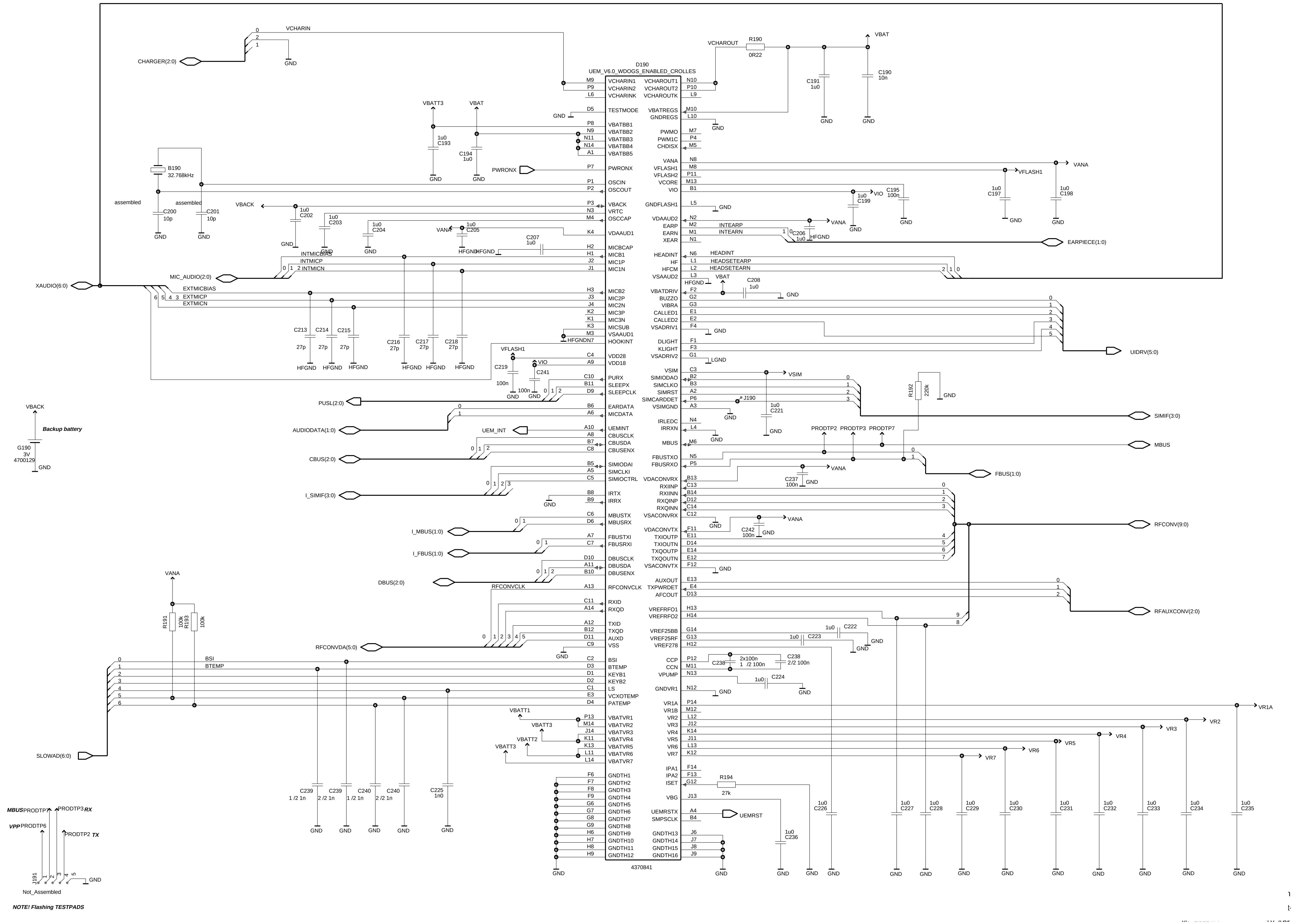
**Power Diagram**



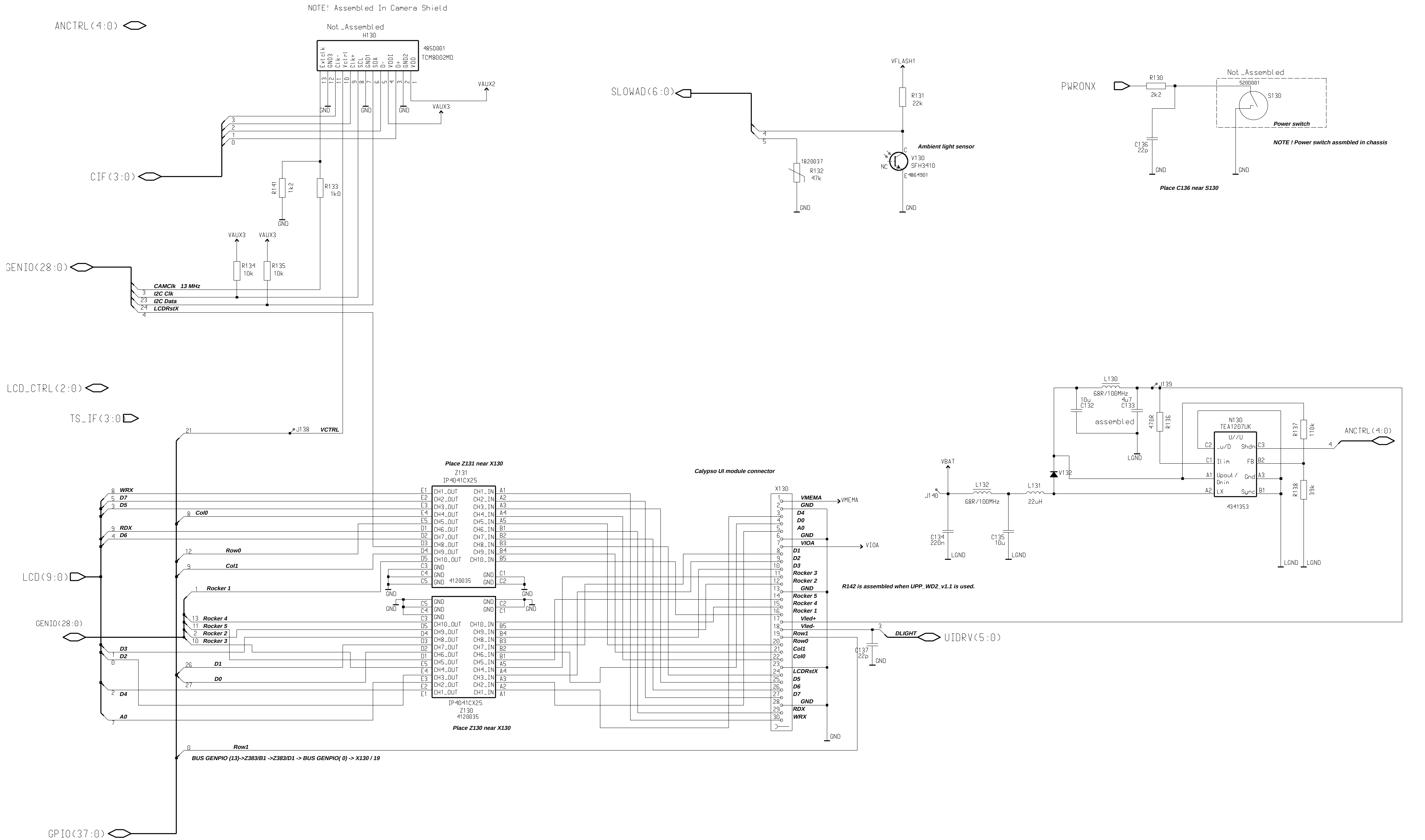
## Audio


UIDRV(5:0)
MIC_AUDIO(2:0)
MICB1
MIC1P
MIC1N
R353 220R
C330
C331 33n
R330 1k0
R331 1k0
C333 4u7
C334 22p
HFGND
14V/46V R332
14V/46V R333
C332 22p
B330
COND.MIC 40+-2DB 2.2K D7.5X4.1
not_assembled
514D001
Place R332 and R333 near mic
Note: there is possibility to use qada_01 if actual adapter is not available 22.03.01
EARPIECE(1:0)
C336 22p
C337 22p
C338 22p
assembled
X331
5409227
CALYPSO EARPIECE ADAPTER DMD07692 NHL-2
14V/46V R334
14V/46V R335
Place R334 and R335 near earpiece
HF_AUDIO(1:0)
C339 22p
C340 22p
C341 22p
SPEAKER 78+-2DB 8R D16.2X3.8
B332
Not_assembled
14V/46V R336
14V/46V R337
Place R336 and R337 near speaker
Audio Chamber Location Holes:
1.6mm beside PWR Switch
E335
E500
1.6mm IN RF AREA.
GND
XAUDIO(6:0)
HEADINT
HFCM
HF
MICB2
MIC2P
MIC2N
HOOKINT
C342 1n0
C343 1n0
SM JACK 2.5MM 5POL+SW SPR.90DEG
5409119
X330
R349 2 /2 22R
R349 1 /2 22R
R338 1k0
R339 2k2
R340 2k2
R348 1k0
R341 1k0
R350 47R
R352 47R
C344 33n
C345 33n
Z330
Z331
Z332
Z333
600R/100MHz
L301 EXC24CB102U
L302 EXC24CB102U
C346 22p
Not_Assembled
C349 100p
C350 22p
10n C353
C347 1n0
C348 1n0
10n C355
10n C356
10n C357
14V/46V R342
14V/46V R343
14V/46V R344
14V/46V R345
14V/46V R346
Place R342 - R346 near X330
Proximity Receiver V335 signals are very sensitive to Noise. Special Attention is needed.
Any Layout Changes must confirmed with EMC/Proximity electrical Desiger.
VBAT
C354 4u7
V334
CL-200IR-X-TU
4860009
PRXIF(2:0)
V335
BPW34FS
4864911
R347 4R3
Place R347 near AEM
PRXBGND
Proximity Sensor
COPYRIGHT(C) NOKIA MOBILE PHONES. ALL RIGHTS RESERVED
THIS DRAWING IS PROTECTED BY COPYRIGHT AS AN UNPUBLISHED WORK
Name
Calypso audio
Assoc
Appr
dd-mmm-yy
Des.
Jarvinen
06-Oct-2000

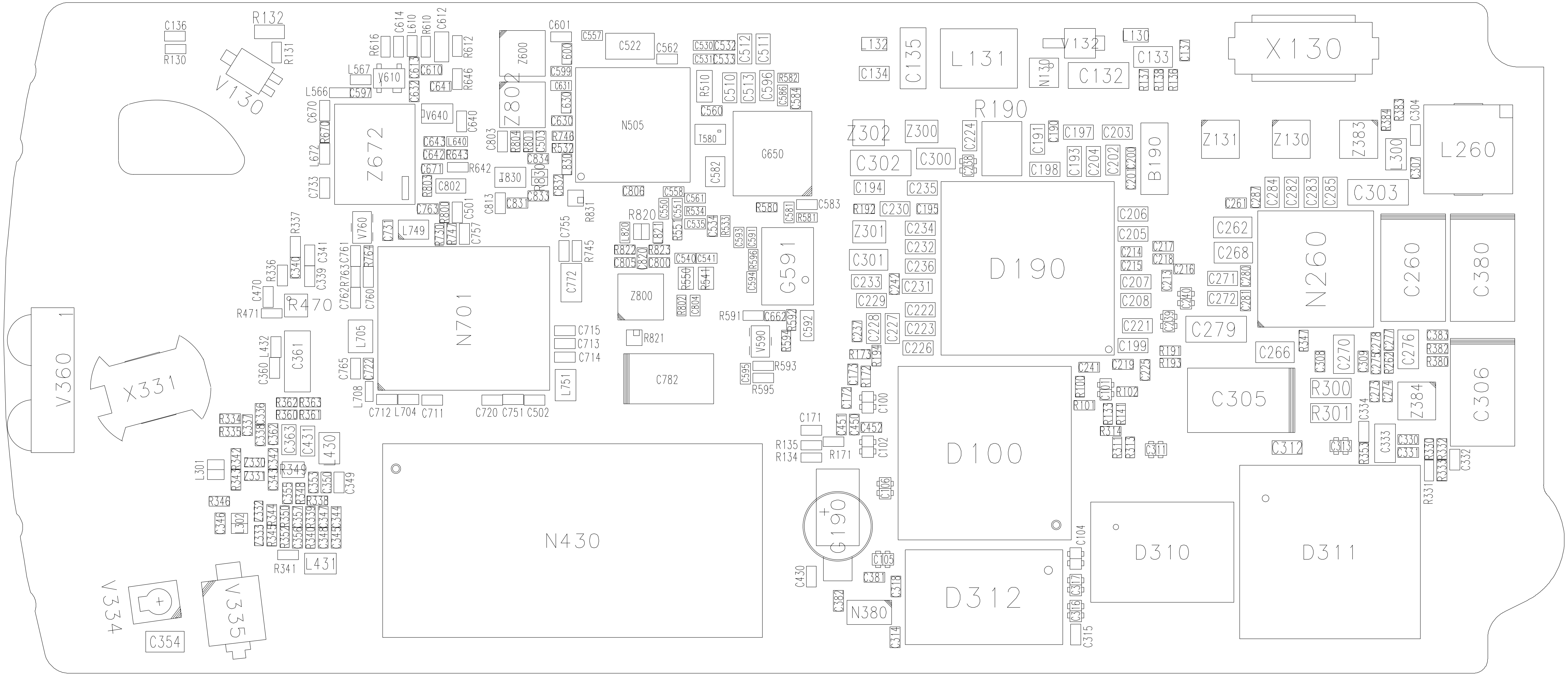
## UEM Diagram



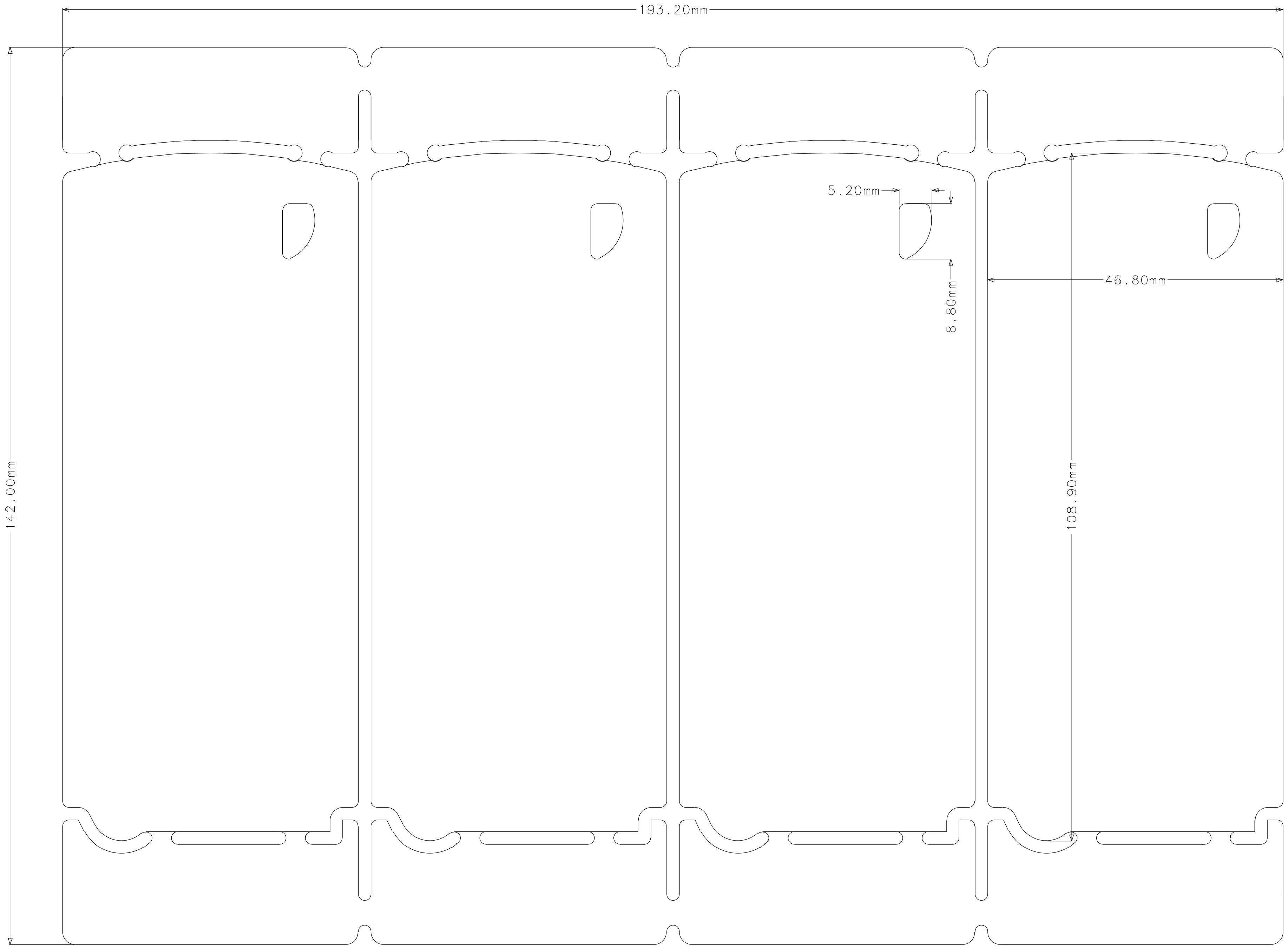
**User Interface Diagram**



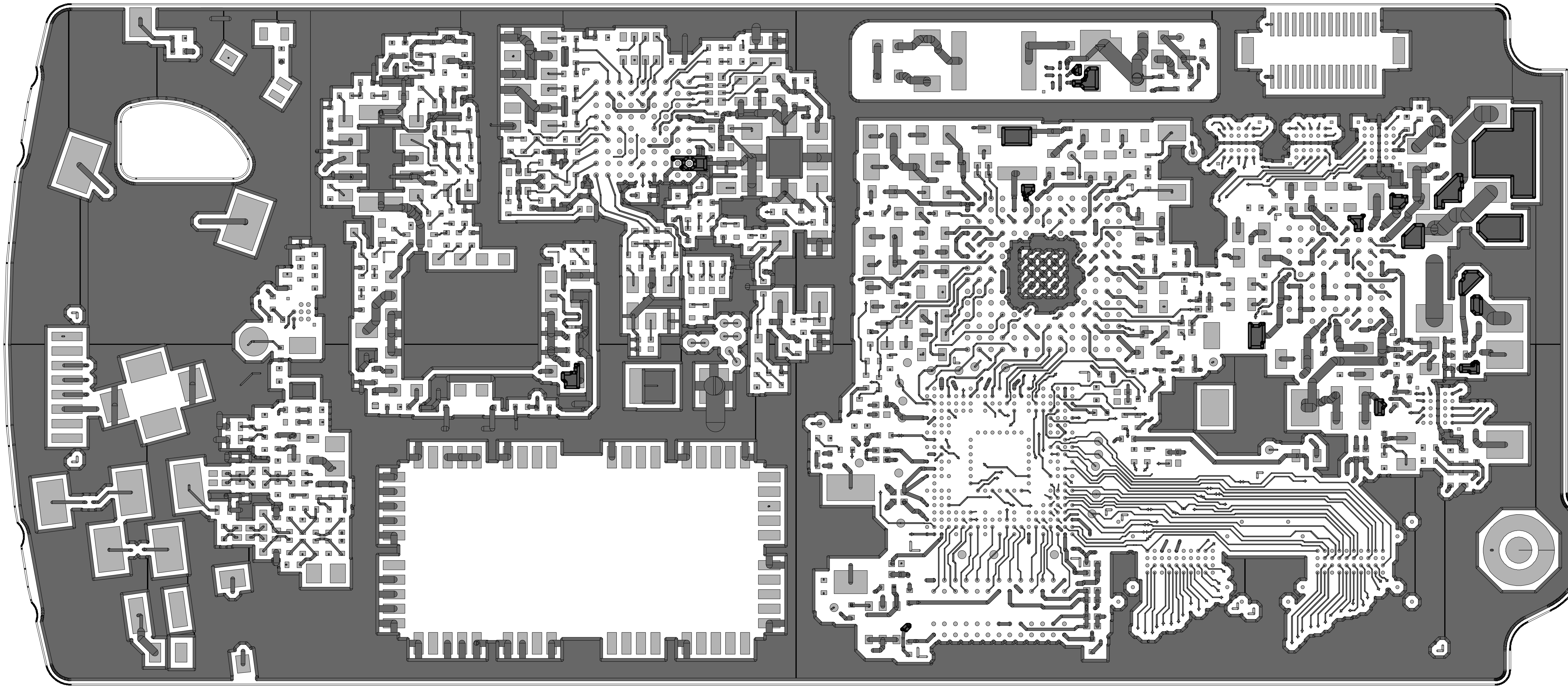
**Parts Placement Diagram LG4**



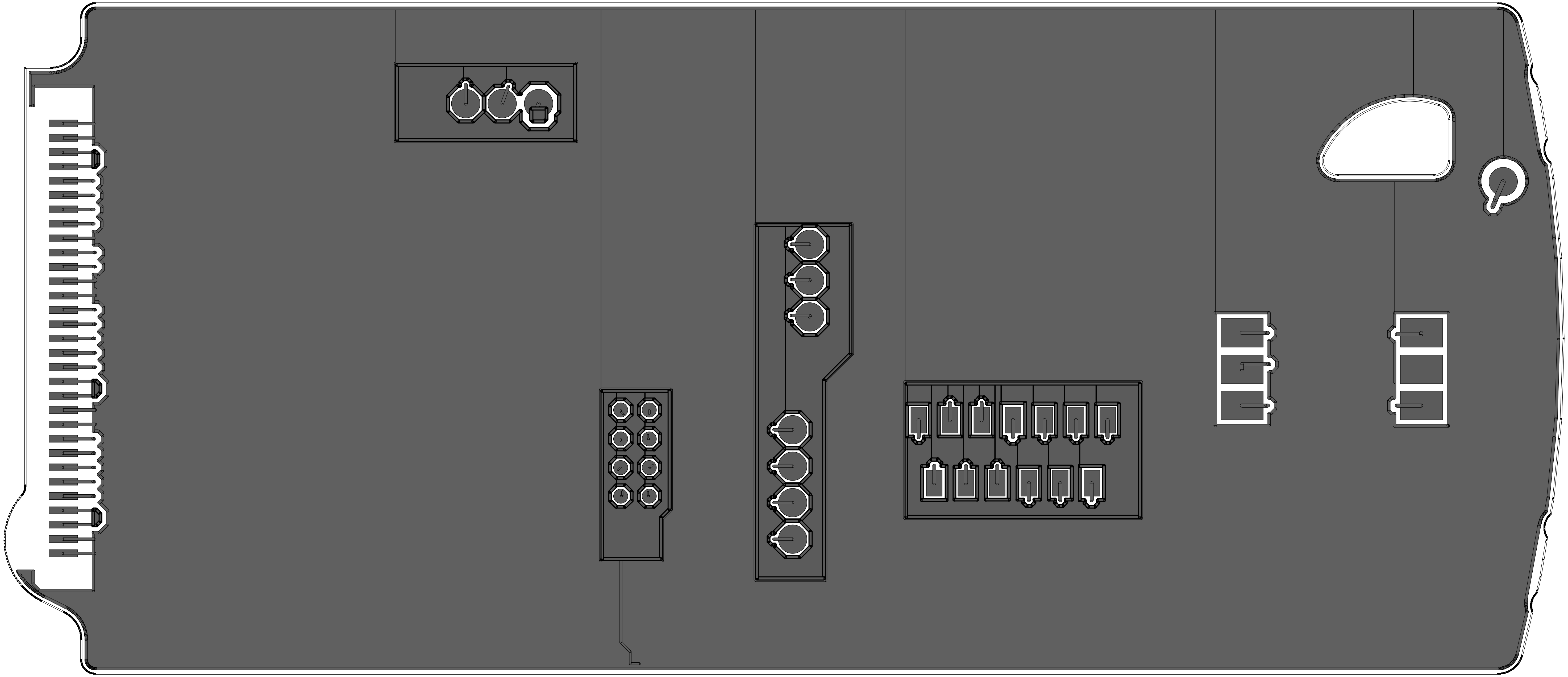
**DIM**



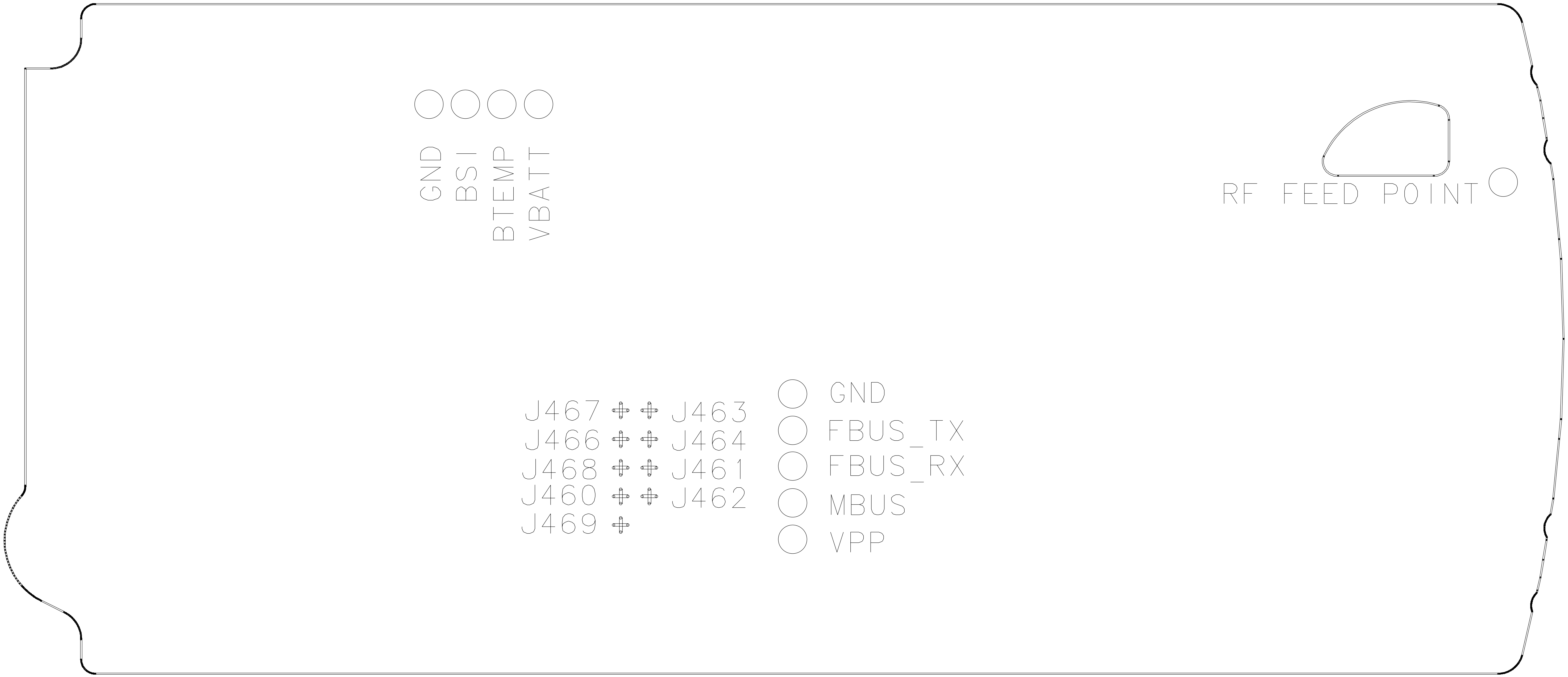
**I1**



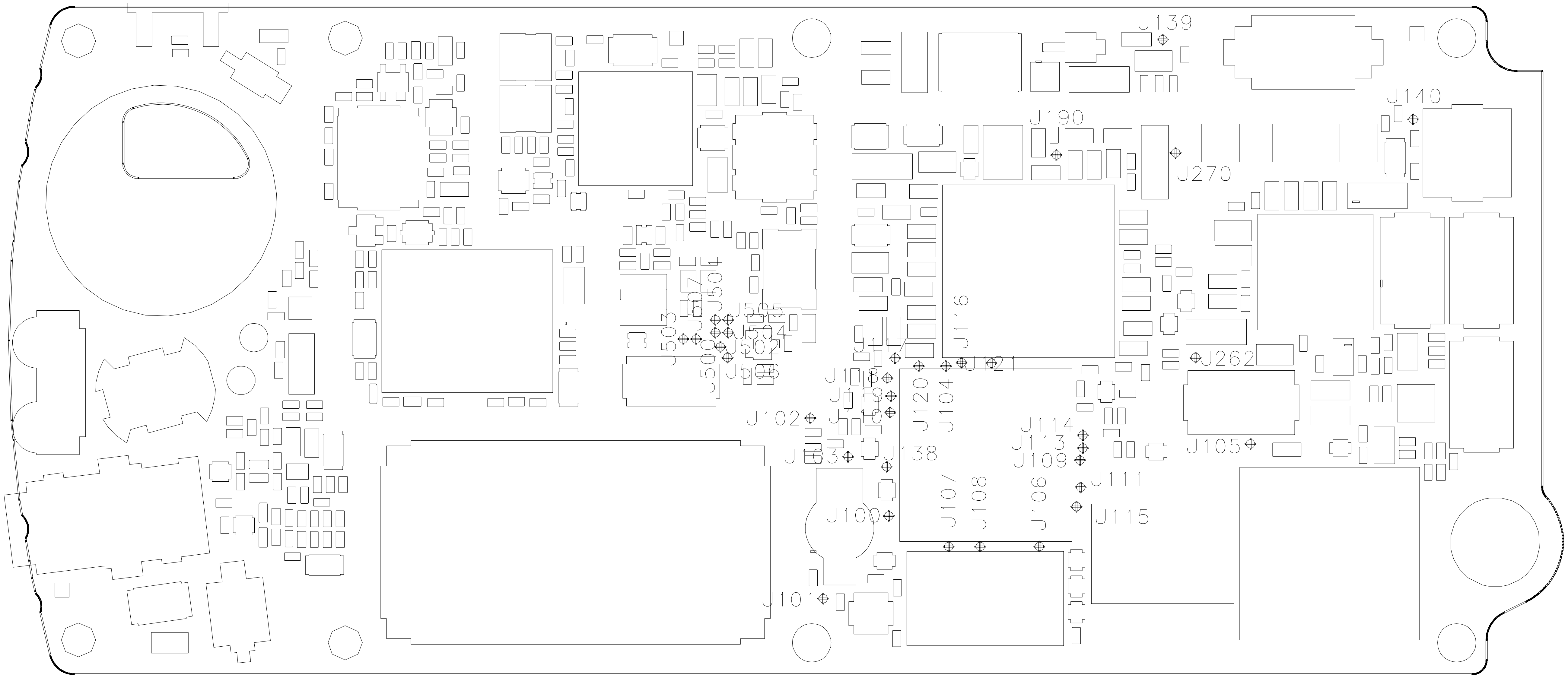
I8



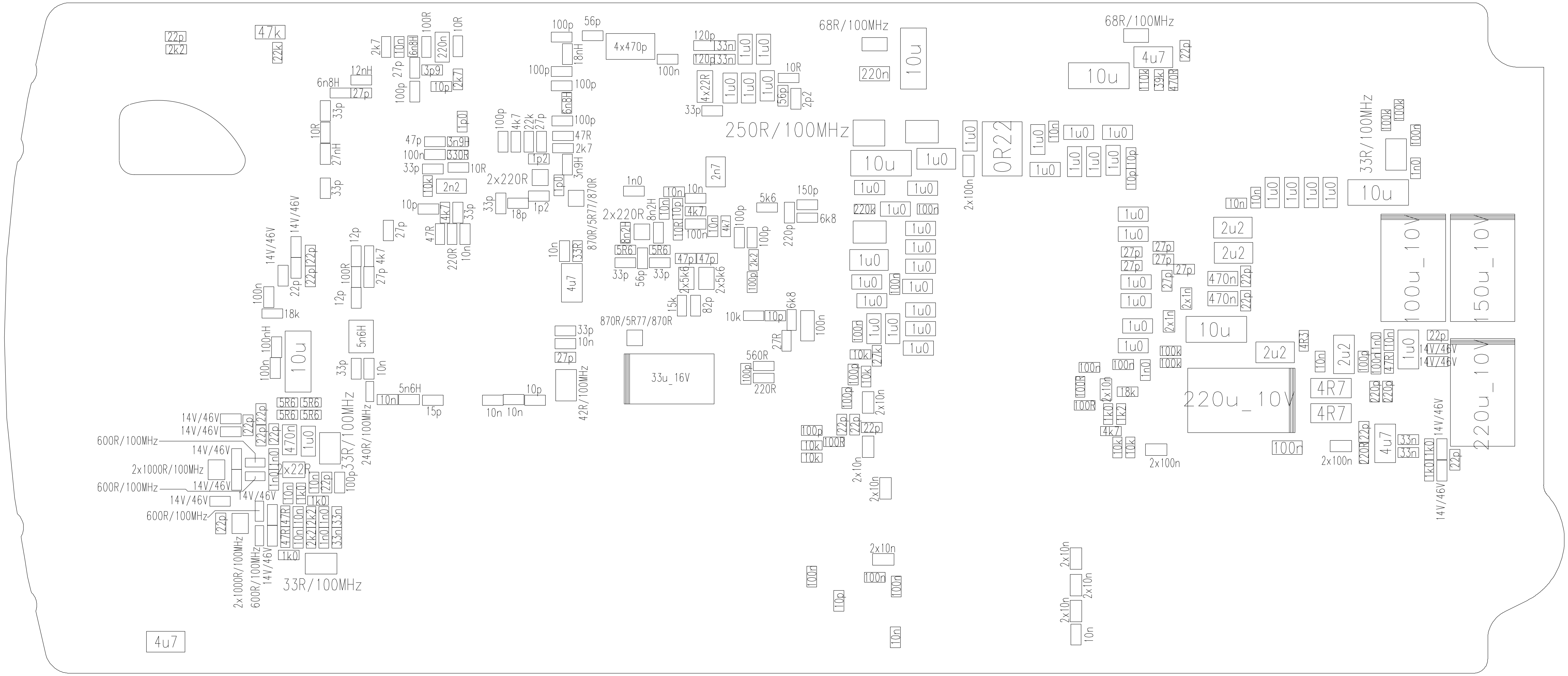
**Testpoints Bottom**



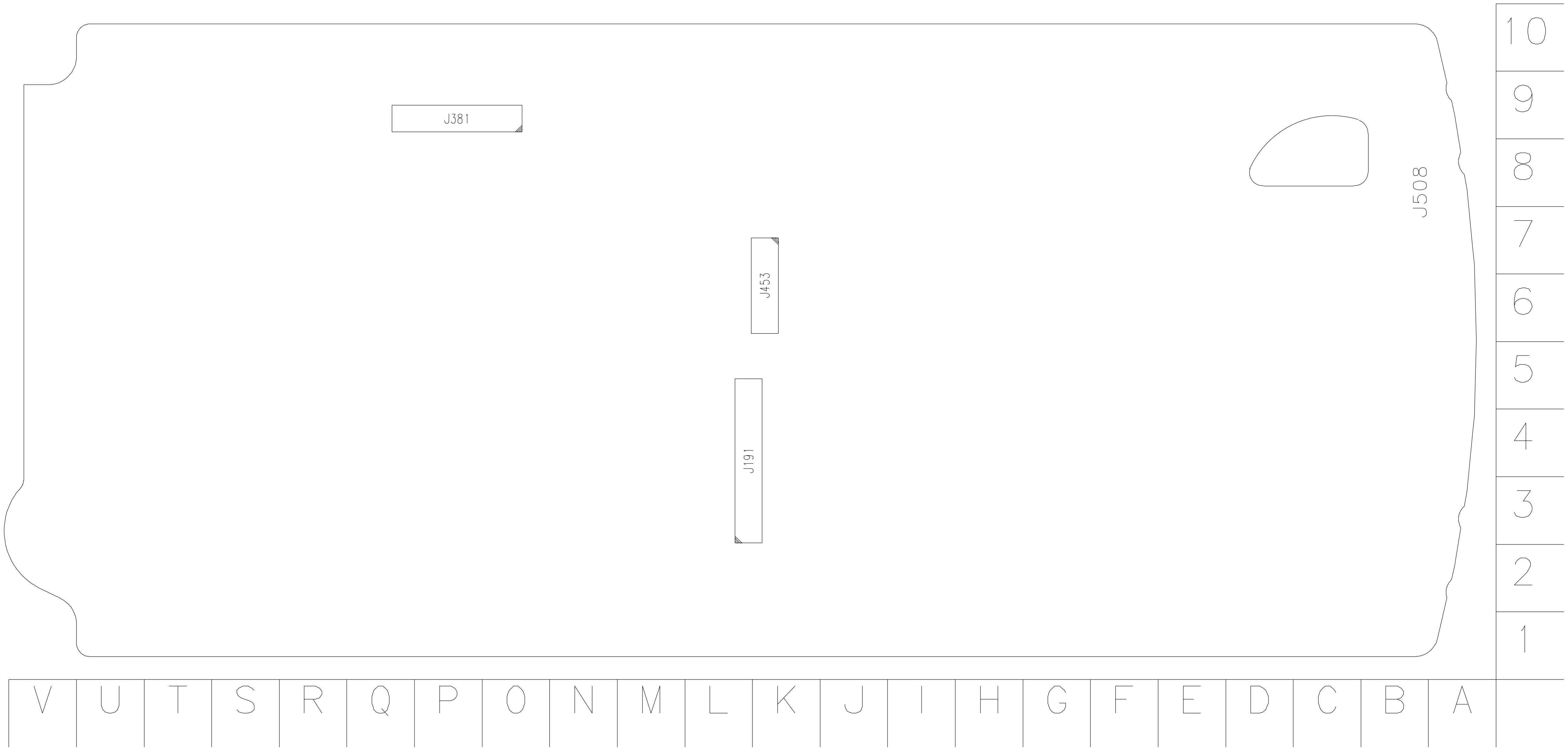
**Testpoints Top**



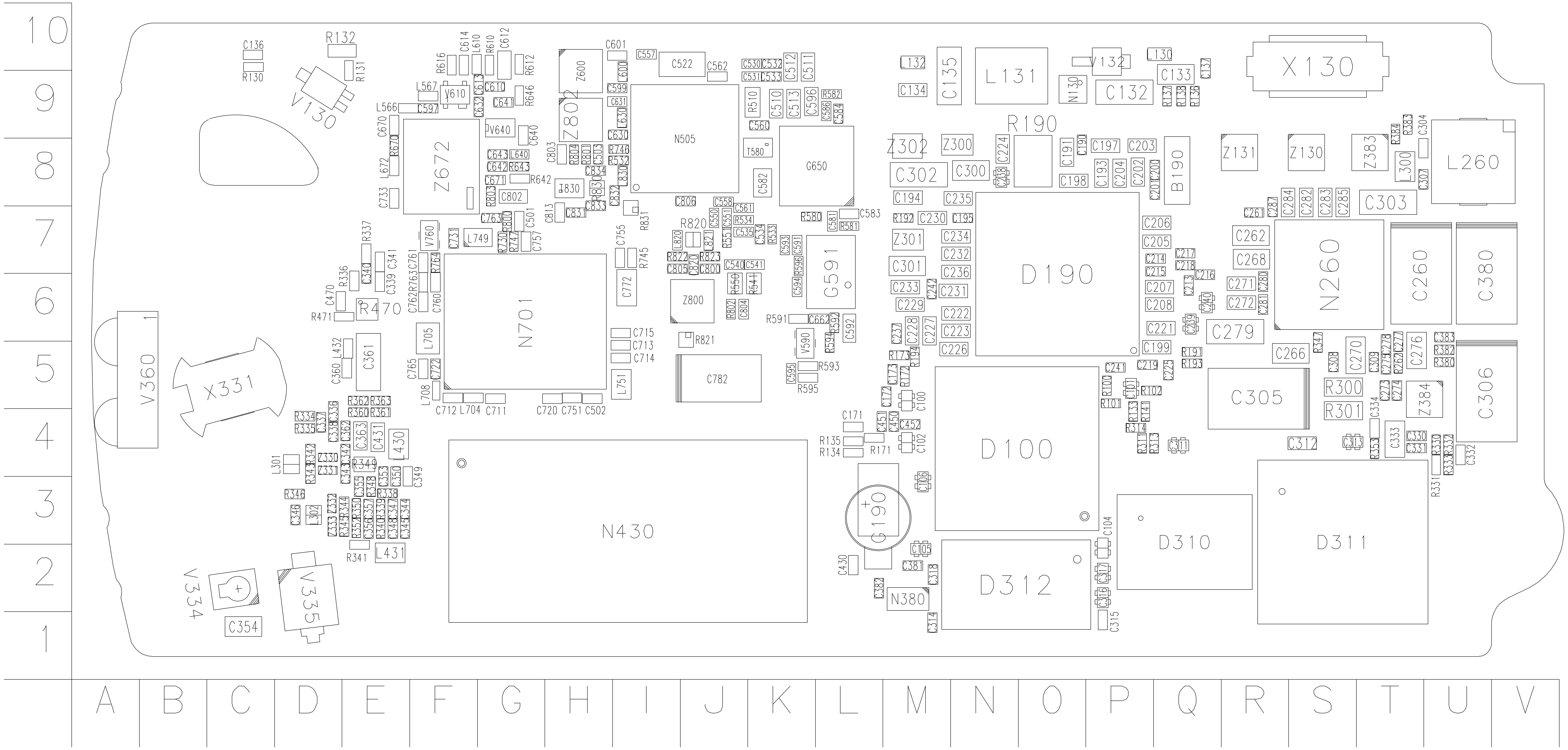
**Values Top**



**ASM Bottom**



**ASM Top**



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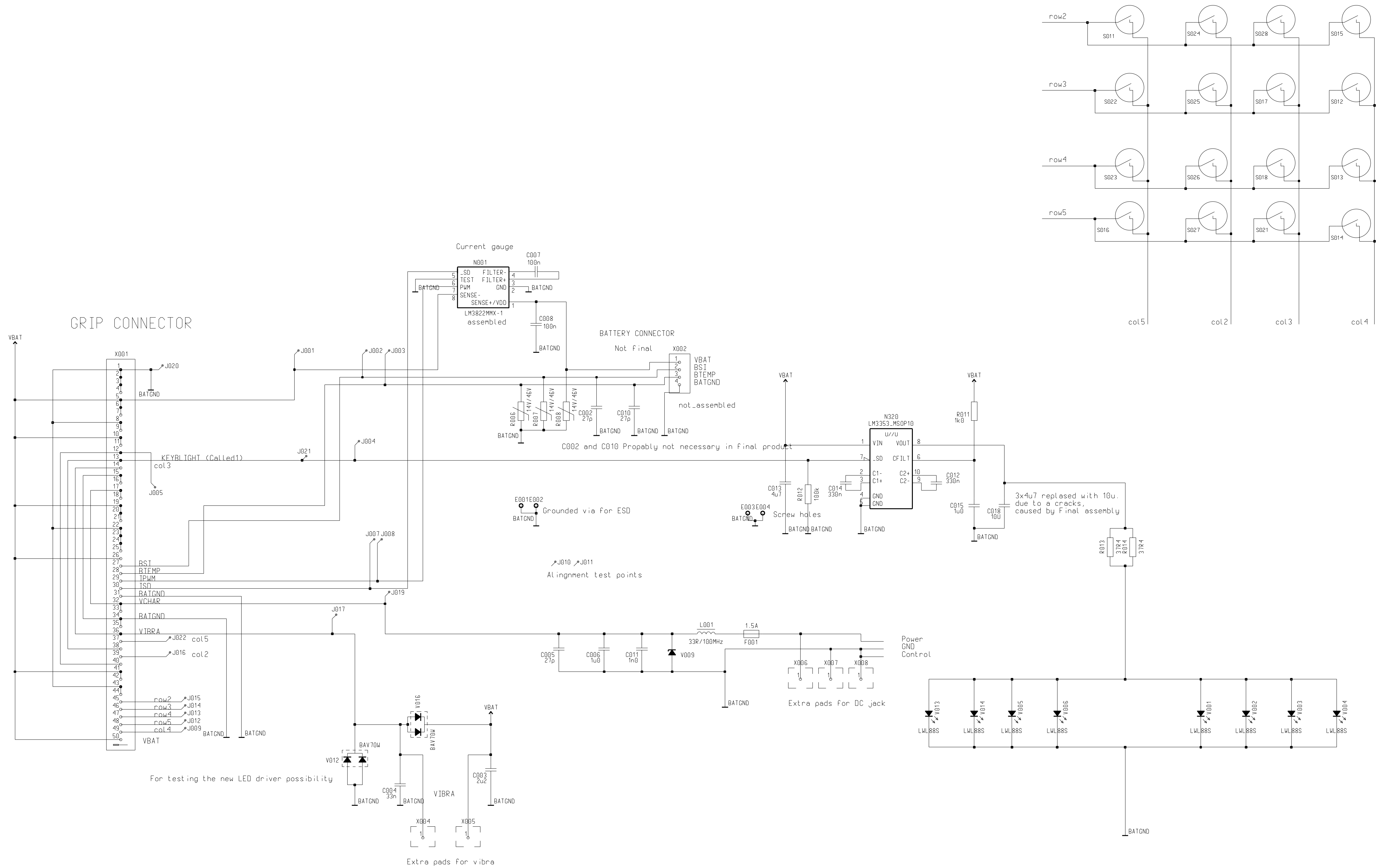
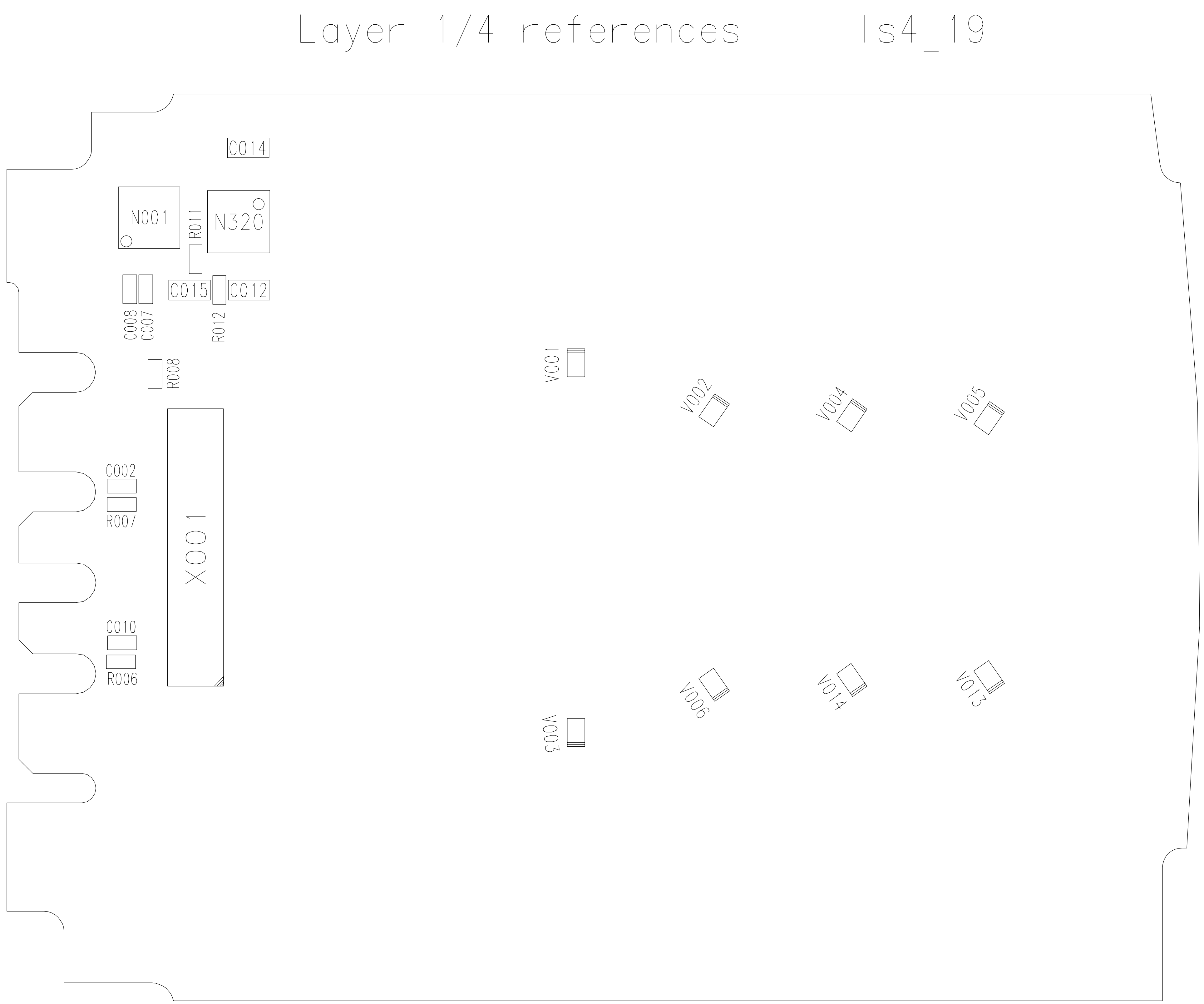
**Block diagram**



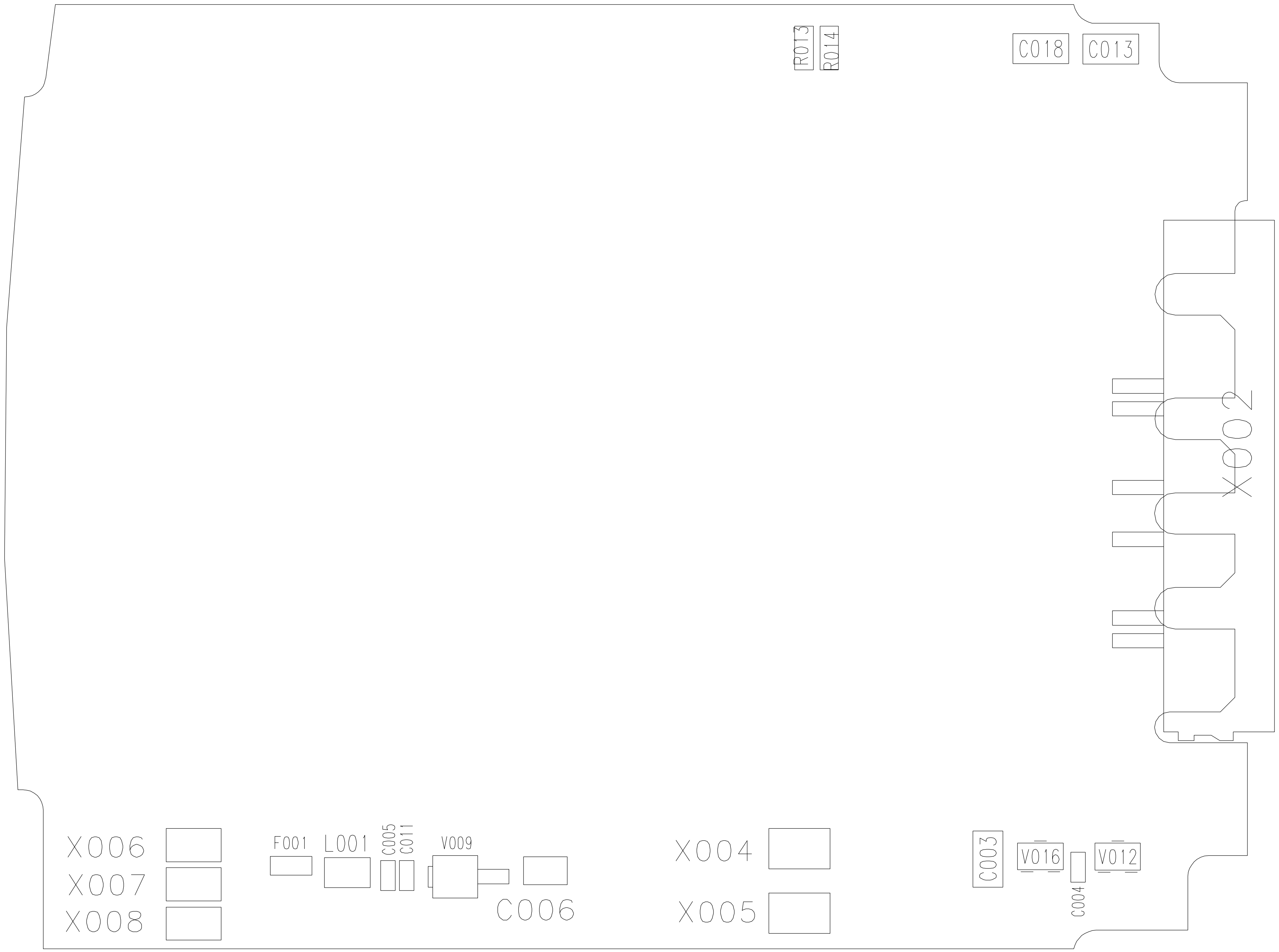

  

**Layer 1/4 refernces**

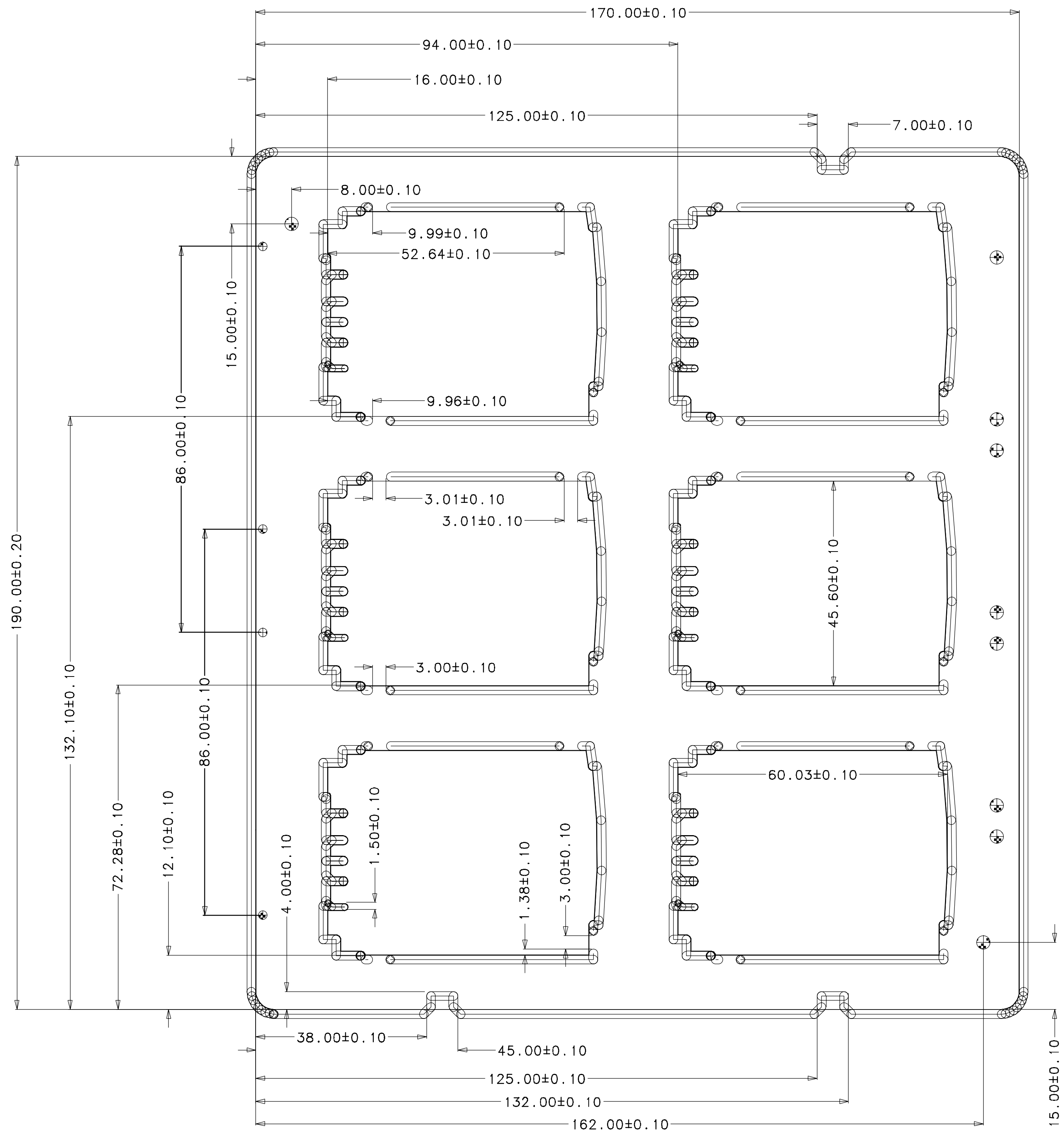


**Layer 4/4 refernces**

Layer 4/4 references ls4_19



**Dim**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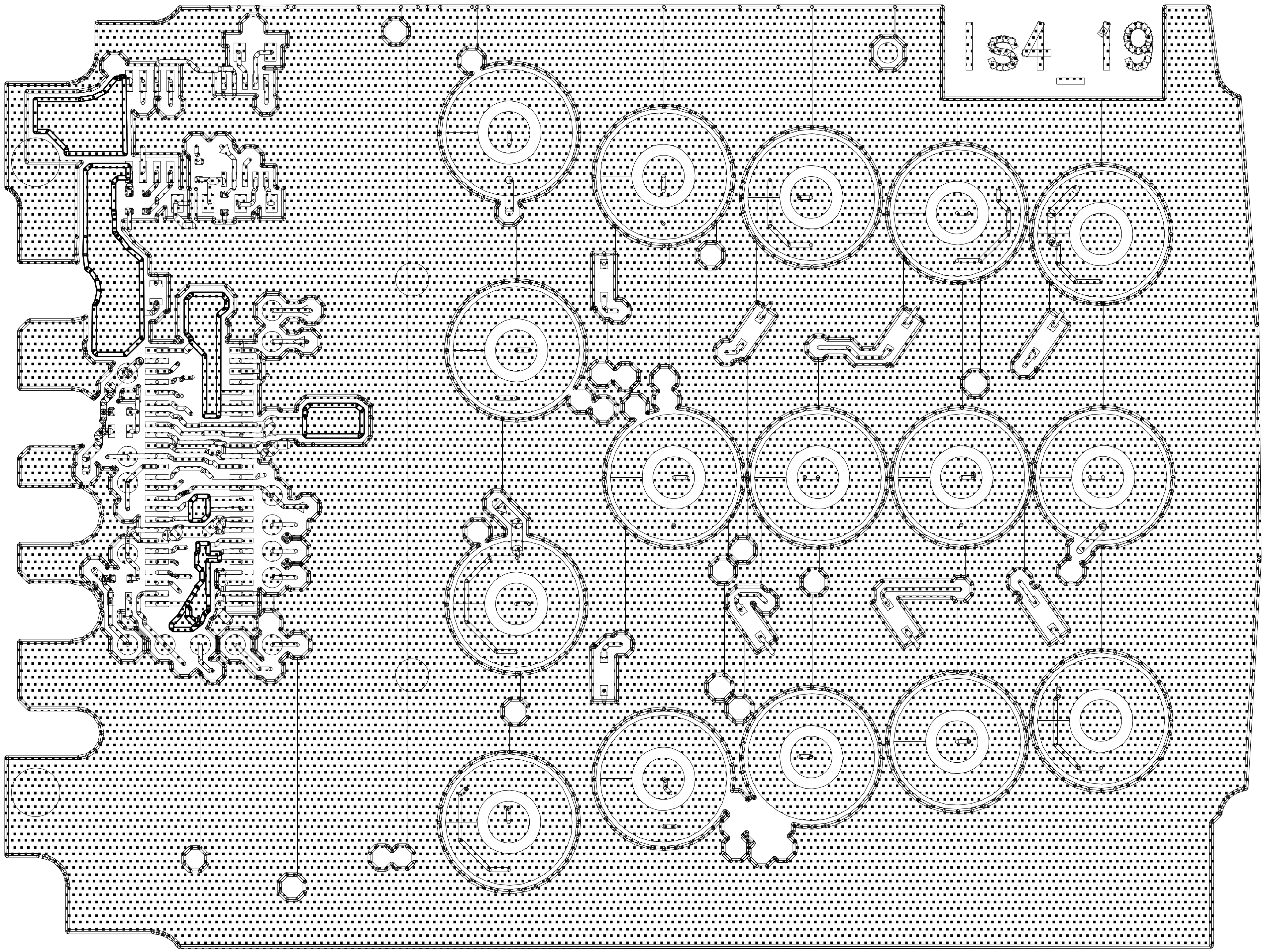
94.00±0.10
16.00±0.10
125.00±0.10
7.00±0.10
8.00±0.10
9.99±0.10
52.64±0.10
15.00±0.10
9.96±0.10
86.00±0.10
3.01±0.10
3.01±0.10
45.60±0.10
190.00±0.20
3.00±0.10
132.10±0.10
86.00±0.10
60.03±0.10
72.28±0.10
12.10±0.10
4.00±0.10
1.50±0.10
1.38±0.10
3.00±0.10
38.00±0.10
45.00±0.10
125.00±0.10
132.00±0.10
162.00±0.10
15.00±0.10

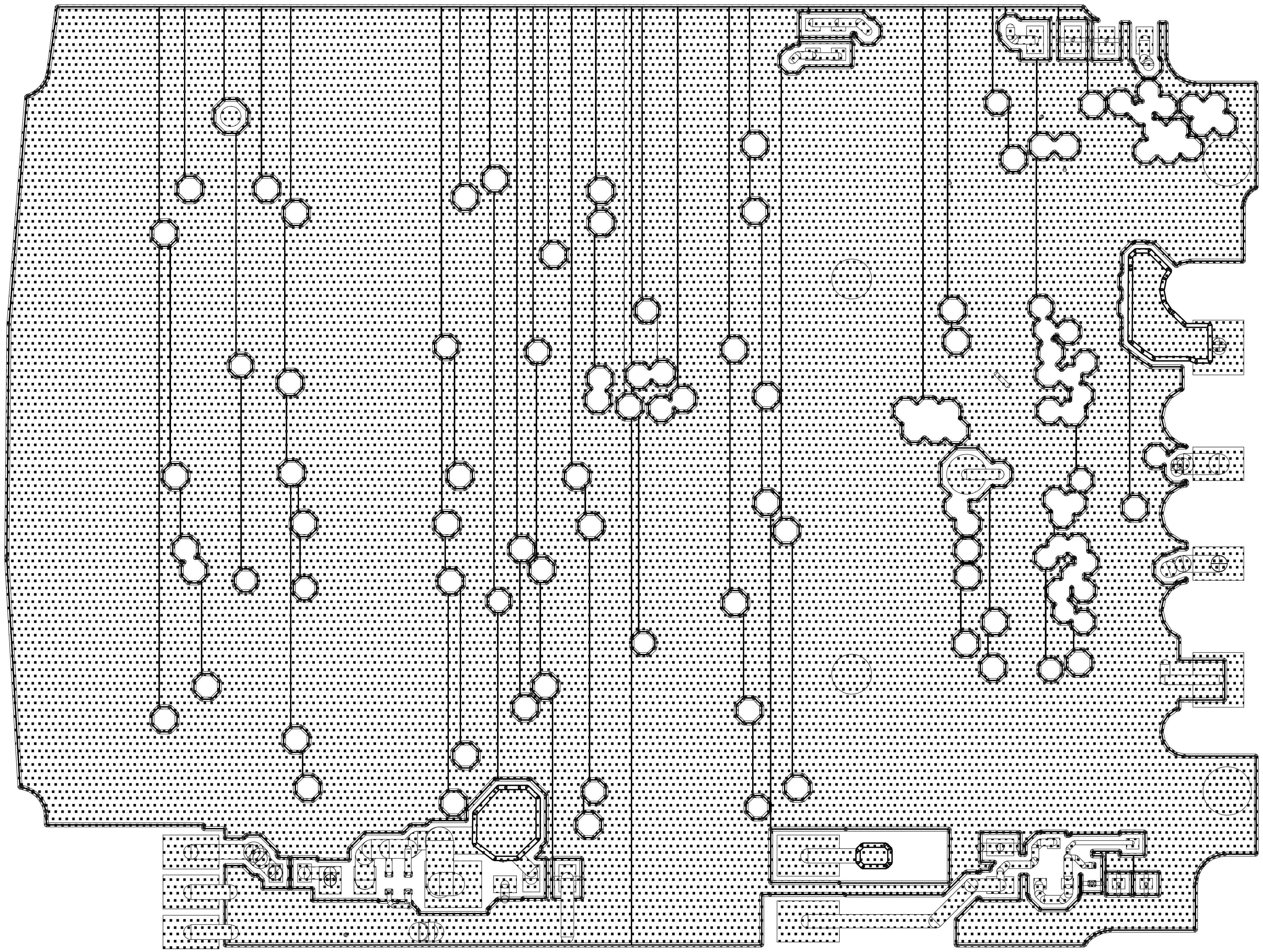
**Layer 1/4**

Layer 1/4 ls4_19

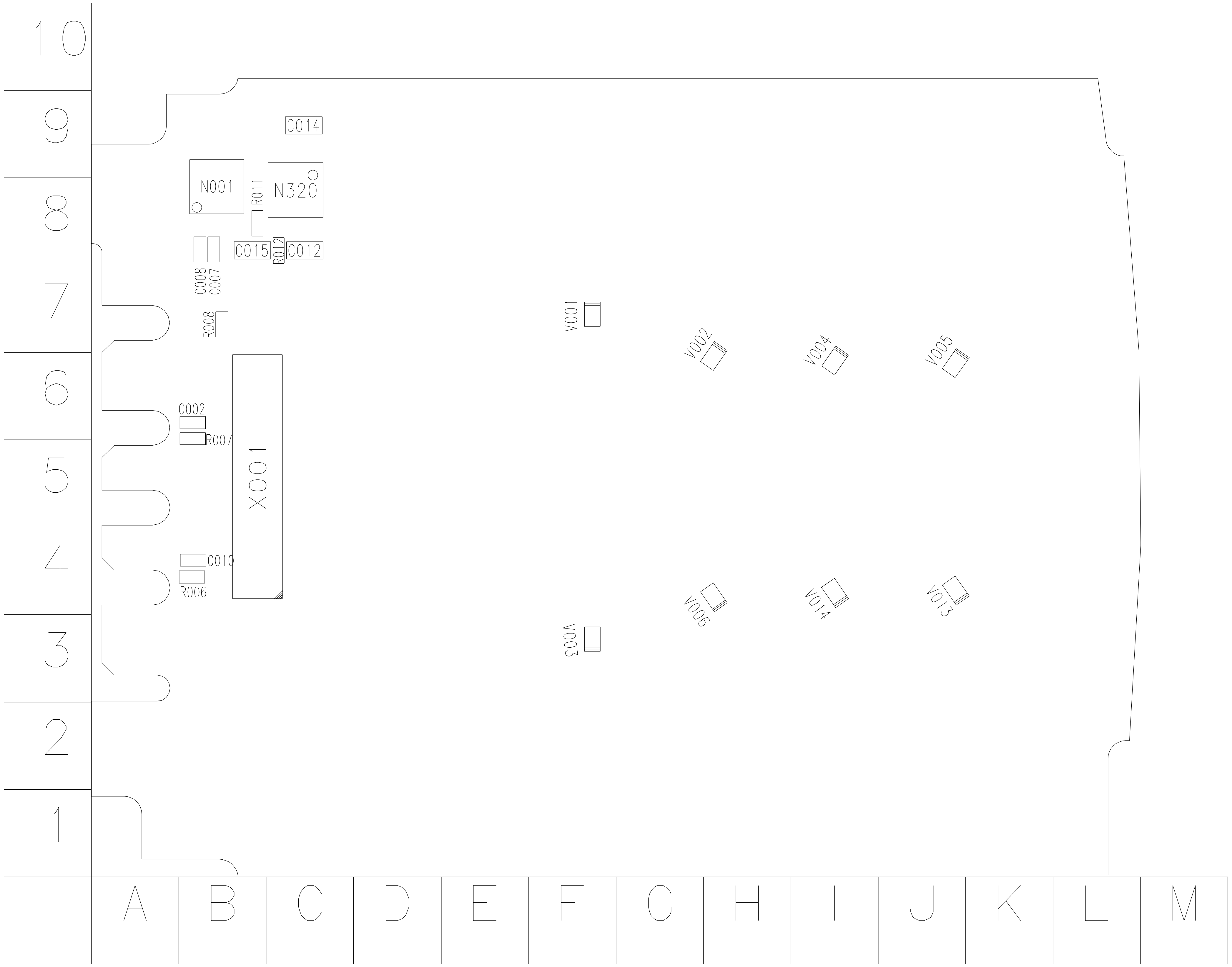


**Later 4/4**

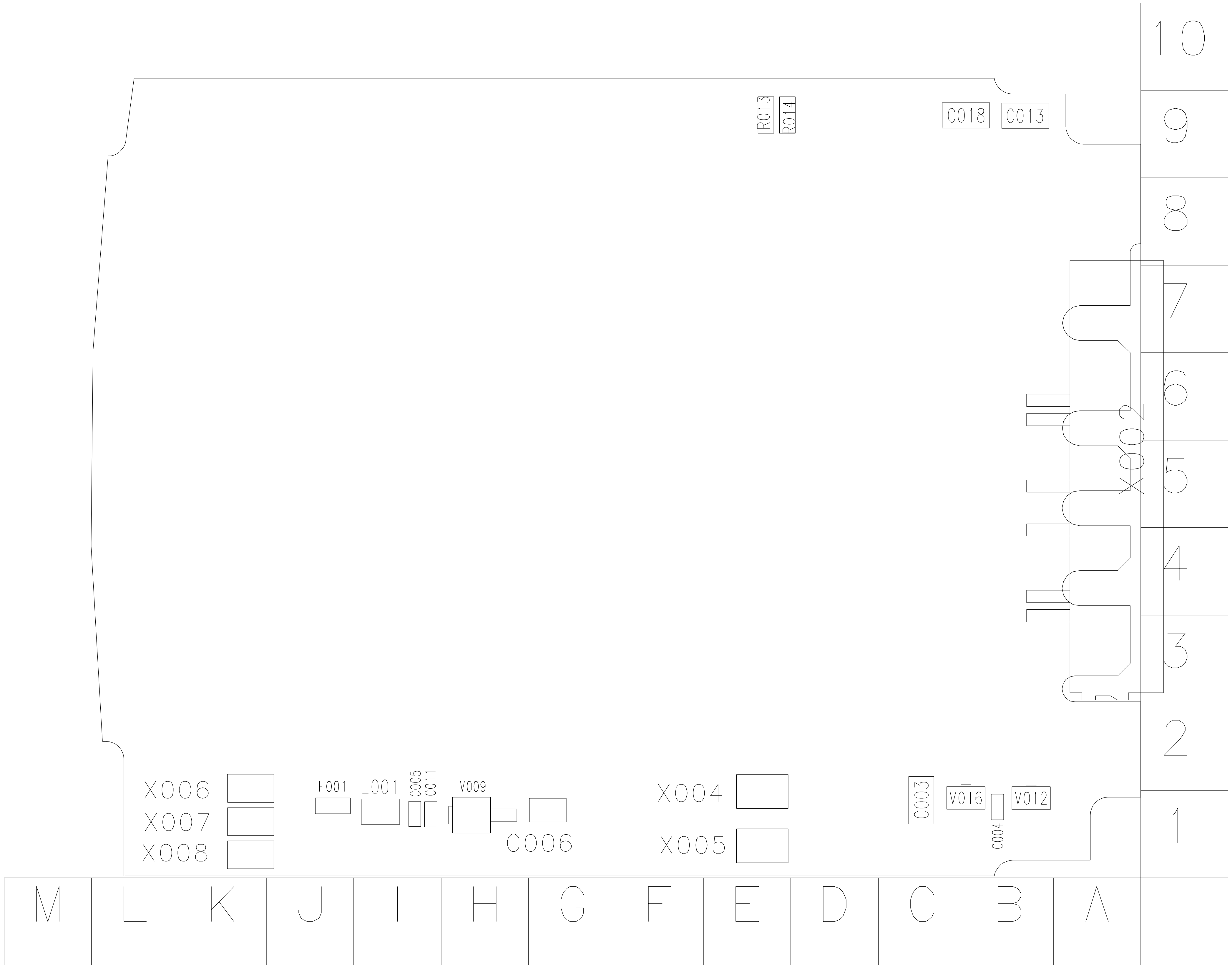
Layer 4/4 ls4_19



**Parts placement diagram LS4 1/2**



**Parts placement diagram LS4 2/2**



# NOTES