

S55/S57 (Hitachi Chipset)

Level 2.5e

Repair Documentation



V 1.00

Version	Date	Department	Notes to change
V 1.00	Dec 2002	ICM MP CCQ GRM	New document

Table of Contents:

1	LIST OF AVAILABLE LEVEL 2,5E PARTS S55/S57	4
2	REQUIRED EQUIPMENT FOR LEVEL 2,5E	5
3	REQUIRED SOFTWARE FOR LEVEL 2,5E S55/S57	5
4	RADIO PART	6
4.1	Power Supply RF-Part	7
4.2	Frequency generation	8
4.2.1	Synthesizer: The discrete VCXO (26MHz).....	8
4.2.2	Synthesizer: LO1	10
4.2.3	Synthesizer: LO2	12
4.2.4	Synthesizer: PLL	13
4.3	Antenna switch (electrical/mechanical).....	14
4.4	Receiver.....	17
4.4.1	Receiver: EGSM900/GSM1800/GSM1900 –Filter to Demodulator	17
4.4.2	IC Overview	19
4.5	Transmitter	20
4.5.1	Transmitter: Modulator and Up-conversion Loop.....	20
4.5.2	Transmitter: Power Amplifier	21
5	LOGIC / CONTROL.....	22
5.1	Overview of Hardware Structure	22
5.1.1	Logic Block Diagram	22
5.1.2	Block Diagram S55/S57 Control Part.....	22
5.1.3	EGOLD+	23
5.1.4	SRAM	27
5.1.5	FLASH	27
5.1.6	SIM	27
5.1.7	Vibration Motor	28
6	POWER SUPPLY.....	28
6.1	Power Supply ASIC	28
6.1.1	Pinout diagram	29
6.1.2	Power Supply Diagram.....	30
6.1.3	Power Supply Operating mode:	31
6.1.4	Power Supply Functions:.....	32
6.2	Battery	34
6.3	Charging Concept.....	34
7	INTERFACES.....	38

7.1	Vibra.....	38
7.2	Earpiece.....	38
7.3	Microphone	39
7.4	Battery	39
7.5	IO Connector with ESD protection	40
7.5.1	IO Connector – New Slim Lumberg	40
7.5.2	ESD Protection with EMI filter	41
7.6	SIM	42
7.7	Display	42
8	ACOUSTIC	43
8.1	Microphone	43
8.1.1	Mechanical	43
8.1.2	Electrical	43
8.2	Soundchip	44
8.3	Earpiece/Loudspeaker	45
8.3.1	Mechanical	45
8.3.2	Electrical	45
9	DISPLAY AND ILLUMINATION.....	46
9.1	Display	46
9.2	Illumination	46
10	KEYBOARD	47
11	BLUETOOTH (ONLY S55).....	47
11.1	Bluetooth Voltage Regulator	48
12	IRDA.....	49

1 List of available level 2,5e parts S55/S57

ID-No	Type	Name, Location	Part-No.
D171	IC	Egold+	L36810-G6144-D670
D361	IC	ASIC	L36145-J4682-Y43
D400	IC	Application_Processor	L36820-L6117-D670
D450	IC	Bluetooth_IC	L36820-L6143-D670
D800	IC	Transceiver IC	L36820-L6105-D670
D890	VCO	Transmitter_VCO	L36820-L6132-D670
D920	IC	PA_Comperator	L36820-L6133-D670
N281	IC	Volt.Regulator_Light	L36810-C6106-D670
N282	IC	Volt.Regulator_Light	L36810-C6098-D670
N3361	IC	Step-Down_Regulator	L36810-C6105-D670
N450	IC	Volt.Regulator_Bluetooth	L36810-C6099-D670
R959	Resistor	Temp_Resistor	L36120-F4223-H
V151	Diode	Diode_KB7	L36840-D5030-D670
V181	Diode	Diode_Battery_Interface	L36702-A1051
V212	Transistor	Tran._Vibra_Light	L36830-C1112-D670
V213	Diode	Diode_SIM_Vibra	L36840-D53-D670
V215	Diode	Diode_IO Connector	L36840-D3084-D670
V361	Transistor	Tran._Charge	L36830-C1110-D670
V450	Diode	Diode_Bluetooth	L36840-D73-D670
V850	Transistor	Tran._VCO_Switch	L36820-C6047-D670
V920	Diode	Feedback_Diode	L36840-D5049-D670
V921	Transistor	Tran._PA_Switch	L36820-C6047-D670
V950	Transistor	Tran._26MHz_Ampl.	L36840-C4049-D670
V951	Diode	Capa_Diode	L36840-D61-D670
Z171	Quartz	Quarz/Egold	L36145-F102-Y10
Z211	Filter	Logic/IO_Interface	L36197-F5000-F116
Z850	VCO	1LO_VCO	L36145-G100-Y96
Z851	Filter	Filter_BALUN	L36145-K260-Y41
Z880	IC	Ant_Switch_Diplexer	L36145-K280-Y244
Z900	IC	Power_Amplifier	L36851-Z2002-A59
Z950	Quartz	Oszillator_26MHz	L36145-F260-Y17

2 Required Equipment for Level 2,5e

- GSM-Tester (CMU200 or 4400S incl. Options)
- PC-incl. Monitor, Keyboard and Mouse
- Bootadapter 2000/2002 ([L36880-N9241-A200](#))
- Adapter cable for Bootadapter due to **new** Lumberg connector
- Troubleshooting Frame S55/S57 ([F30032-P208-A1](#))
- Power Supply
- Spectrum Analyser min. 4GHz
- Active RF-Probe incl. Power Supply
- Oscilloscope incl. Probe
- RF-Connector (N<>SMA(f))
- Power Supply Cables
- Dongle ([F30032-P28-A1](#)) if USB-Dongle is used a special driver for NT is required
- BGA Soldering equipment

Reference: Equipment recommendation V1.2
(downloadable from the technical support page)

3 Required Software for Level 2,5e S55/S57

- Windows NT Version4
- Winsui version1.42 or higher
- Software for GSM-Tester (Cats(Acterna/Wiltek) or CMU-GO(Rohde&Schwarz))
- Software for reference oscillator adjustment
- Internet unblocking solution
- Dongle driver for USB-Dongle if used with WIN NT4

4 Radio Part

The radio part of the S55/S57, is using a Hitachi and an Infineon RF chip-set. This manual covers the Hitachi chip-set.

The radio part is designed for Tripple Band operation, covering EGSM900, GSM1800 as well as GSM 1900 frequencies, and can be divided into 4 Blocks.

- Power supply for RF-Part
- Transmitter
- Receiver
- Synthesizer,

The RF-Part has it's own power supply realised by a voltage regulator which is located inside the ASIC. The voltages for the logic part are generated by the Power-Supply ASIC too.

The transmitter part converts the I/Q base band signals supplied by the logic (EGOLD+) into RF-signals with characteristics as defined in the GSM recommendation (www.etsi.org) After amplification by a power Amplifier the signal is radiated via the internal or external antenna.

The receiver part converts the received GMSK signal supplied by the antenna into IQ base band signals which are further processed by the logic (EGOLD+).

The synthesizer generates the required frequencies for the transmitter and receiver. A 26MHz oscillator is acting as a reference frequency.

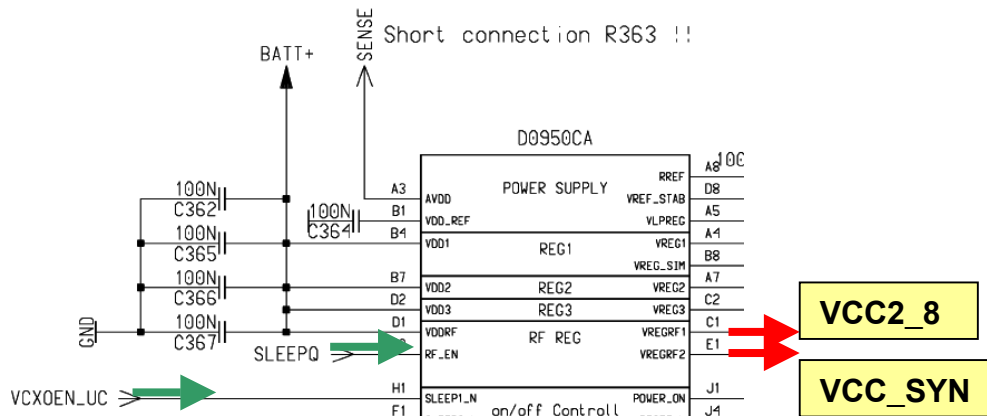
Restrictions:

The mobile phone can never transmit and receive in both bands simultaneously. Only the monitor time slot can be selected independently of the frequency band. Transmitter and receiver can of course never operated simultaneously.

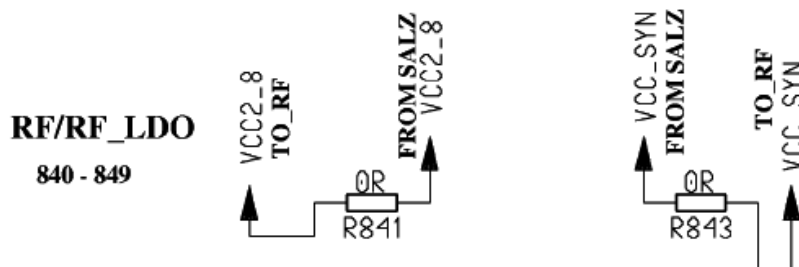
4.1 Power Supply RF-Part

The voltage regulator for the RF-part is located inside the ASIC D361. (see chapter 5.2). It generates the required 2,8V "RF-Voltages" named **VCC2_8** and **VCC_SYN**. The voltage regulator is activated as well as deactivated via **SLEEPQ** (TDMA-Timer H16) and **VCXOEN_UC** (Miscellaneous R6) provided by the **EGOLD+**. The temporary deactivation is used to extend the stand by time.

Circuit diagram



Between Power Supply ASIC and RF-Part a resistor based interface consisting of resistor **R841** for **VCC2_8** and **R843** for **VCC_SYN** is used.



4.2 Frequency generation

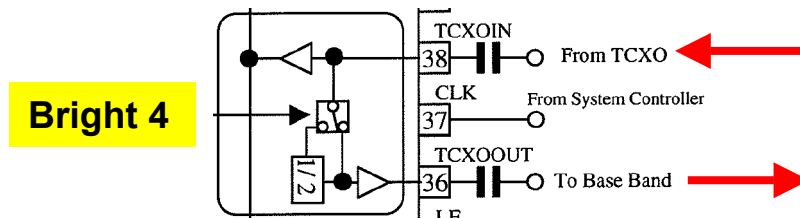
4.2.1 Synthesizer: The discrete VCXO (26MHz)

The S55/S57 mobile is using a reference frequency of 26MHz for the Hitachi chip set. The generation of the 26MHz signal is done via a discrete "Colpitts" VCXO. This oscillator consists mainly of:

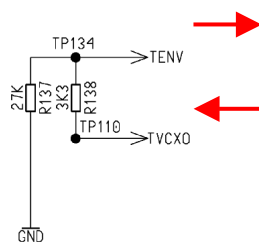
A 26MHz crystal Z950
An oscillator switch V950
A capacity diode V951

TP (test point) of the 26MHz signal is the TP 1501

The oscillator output signal 26MHz_RF is directly connected to the BRIGHT IC (pin 38) to be used as reference frequency inside the Bright (PLL). The signal leaves the Bright IC as BB_SIN26M at (pin 36) to be further used from the EGOLD+ (D100 (functional T3)).



To compensate frequency drifts (e.g. caused by temperature) the oscillator frequency is controlled by the (AFC) signal, generated through the internal EGOLD+ (D100 (functional U5)) PLL via the capacity diode V951. Reference for the "EGOLD-PLL" is the base station frequency. To compensate a temperature caused frequency drift, the temperature-depending resistor R959 is placed near the VCXO to measure the temperature. The measurement result TVCXO is reported to the EGOLD+(Analog Interface P3) via R138 as the signal TENV.

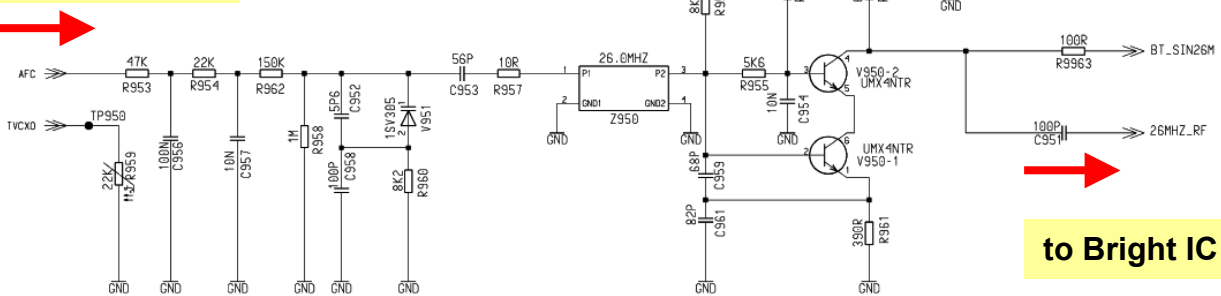


The required voltage VCC_SYN is provided by the ASCI D361

Circuit diagram

RF/Crystal_Oscillator
950 - 999

from EGOLD



The VCO (Z850) is switched on by the EGOLD+ signal PLLON (TDMA-Timer F16) via V850 and therefore supplied with VCC2_8. The VCO guarantees by using the control voltage at pin5 a coverage of the EGSM900, GSM1800 and GSM1900 frequency band and frequency stability. The Bright gained control voltage passes on the way to the VCO a discreet loop filter (typical value from 0,5 – 2,1V).

The channel programming of the PLL happens via the EGOLD+ signals RFDATA; RFCLK; RFSTR. (RF Control J15, J16, J17). If the Bright IC gets via the same signals a GSM1800 channel information, the VCO is switched to this frequency by Pin 42 Bright (Pin 3 VCO).

For GSM900 - RX= "low signal" for Channel 975-49 "high signal" for channel 50-124

- TX= "high signal" for all channels

For GSM1800 - RX= "low signal" for all channels

- TX= "low signal" for all channels

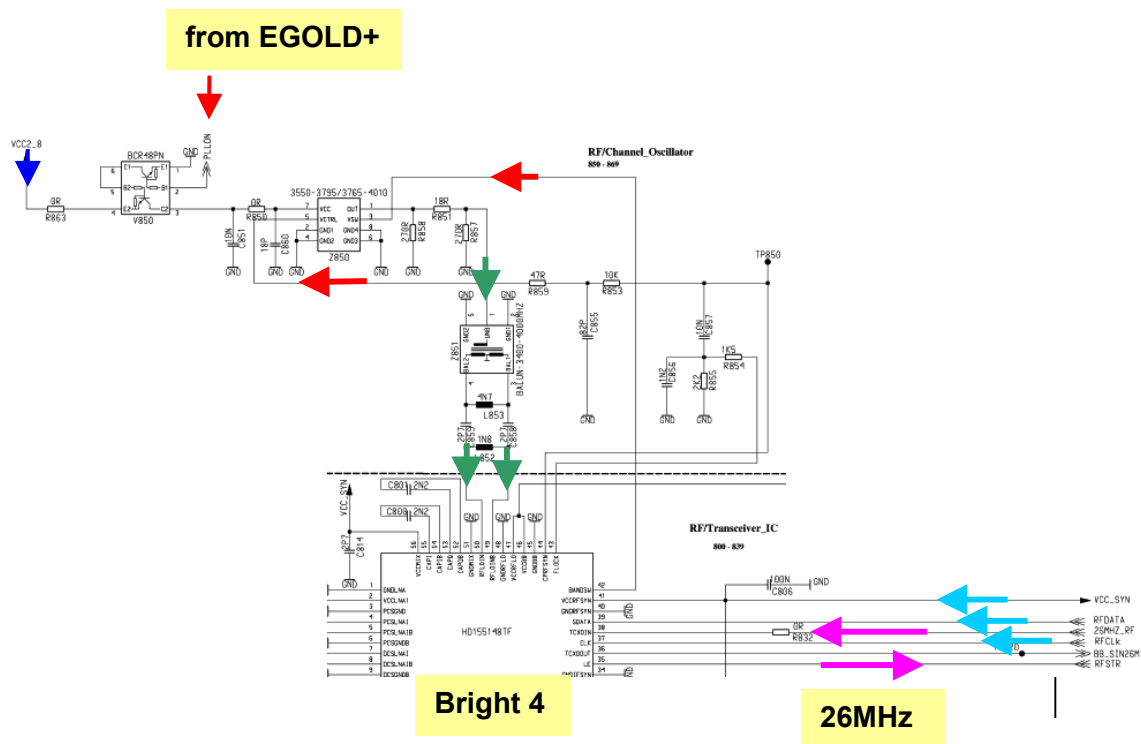
For GSM1900 - RX= "low signal" for all channels

- TX= "low signal" for all channels

The VCO output signal passes the "Balun" transformer (Z851) with insertion losses of ~ 2dB to arrive at the Bright IC.

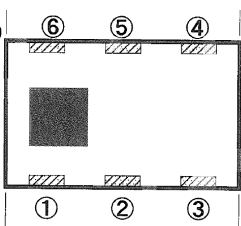
The required voltage VCC8_8 is provided by the ASIC D361

Circuit diagram



Balun transformer

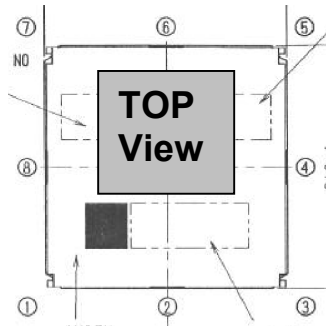
(TOP VIEW)



PIN FUNCTION

- ① Unbalanced Port
- ② GND
- ③ Balanced Port1
- ④ Balanced Port2
- ⑤ GND
- ⑥ N. C

VCO



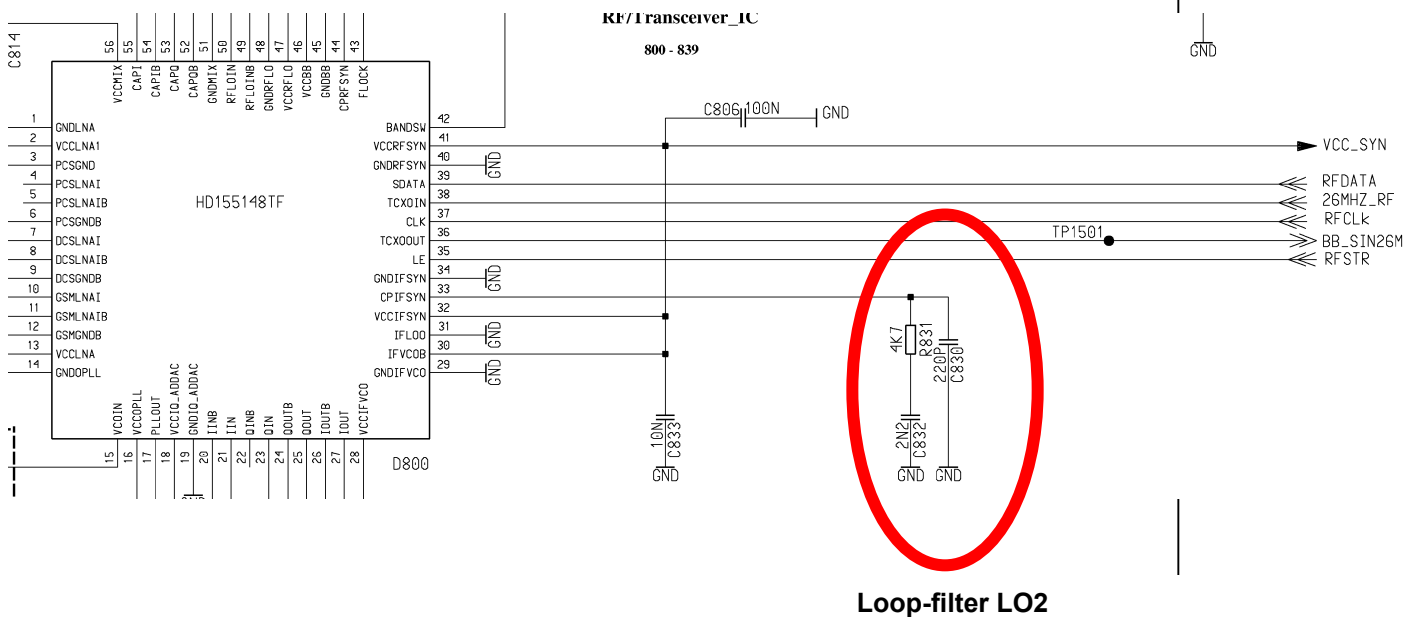
TERMINAL NO.	CONTENTS
1	OUT
2	GND
3	SW
4	GND
5	VCTL
6	GND
7	VCC
8	GND

4.2.3 Synthesizer: LO2

The second local oscillator is required for transmitter operations only. It consists of a PLL and a VCO which are integrated inside the Bright 4, and an external second order loopfilter (R831; C830; C832). Before the VCO generated 640 or 656MHz signal arrives at the modulator, it is divided by 8. So the resulting frequency after the IQ modulator is 80/82MHz (depending on channel and band). Programming of the LO2 PLL is done in the same way as described at the LO1. The tree-wire-bus (EGOLD+ signals RFDATA; RFCLK; RFSTR. (RF Control J15, J16, J17) is used. To ensure the frequency stability, the 640MHz VCO signal is compared by the phase detector of the 2nd PLL with the 26MHz reference signal. The resulting control signal passes the external loop filter and is used to control the 640/656MHz VCO.

The required voltage **VCC_SYN** is provided by the ASIC D361

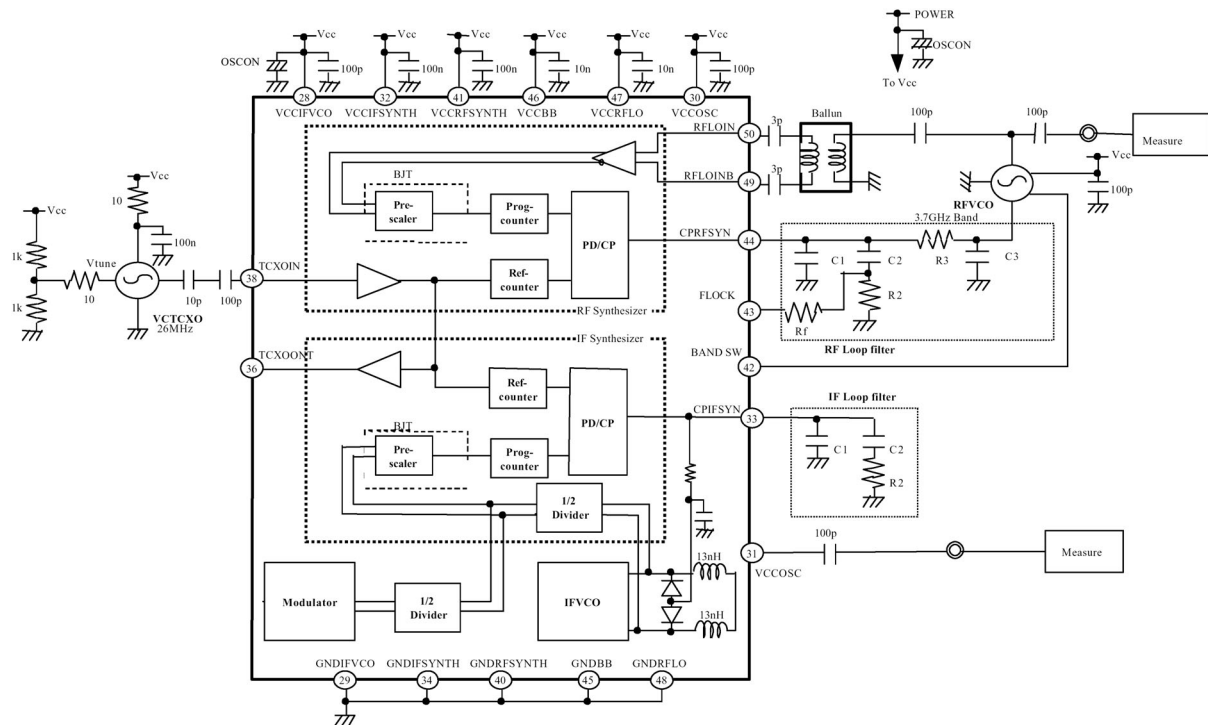
Circuit diagram



4.2.4 Synthesizer: PLL

PLL as a part of the BRIGHT IC

Blockdiagram



4.3 Antenna switch (electrical/mechanical)

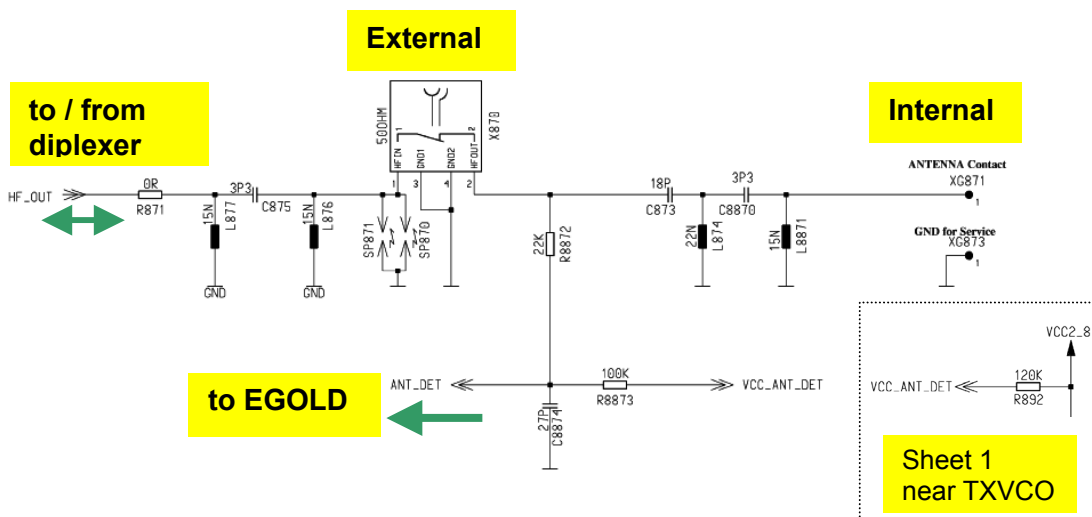
Internal/External <> EGSM900/GSM1800/GSM1900 <> Receiver/Transmitter

The S55/S57 mobile has two antenna switches.

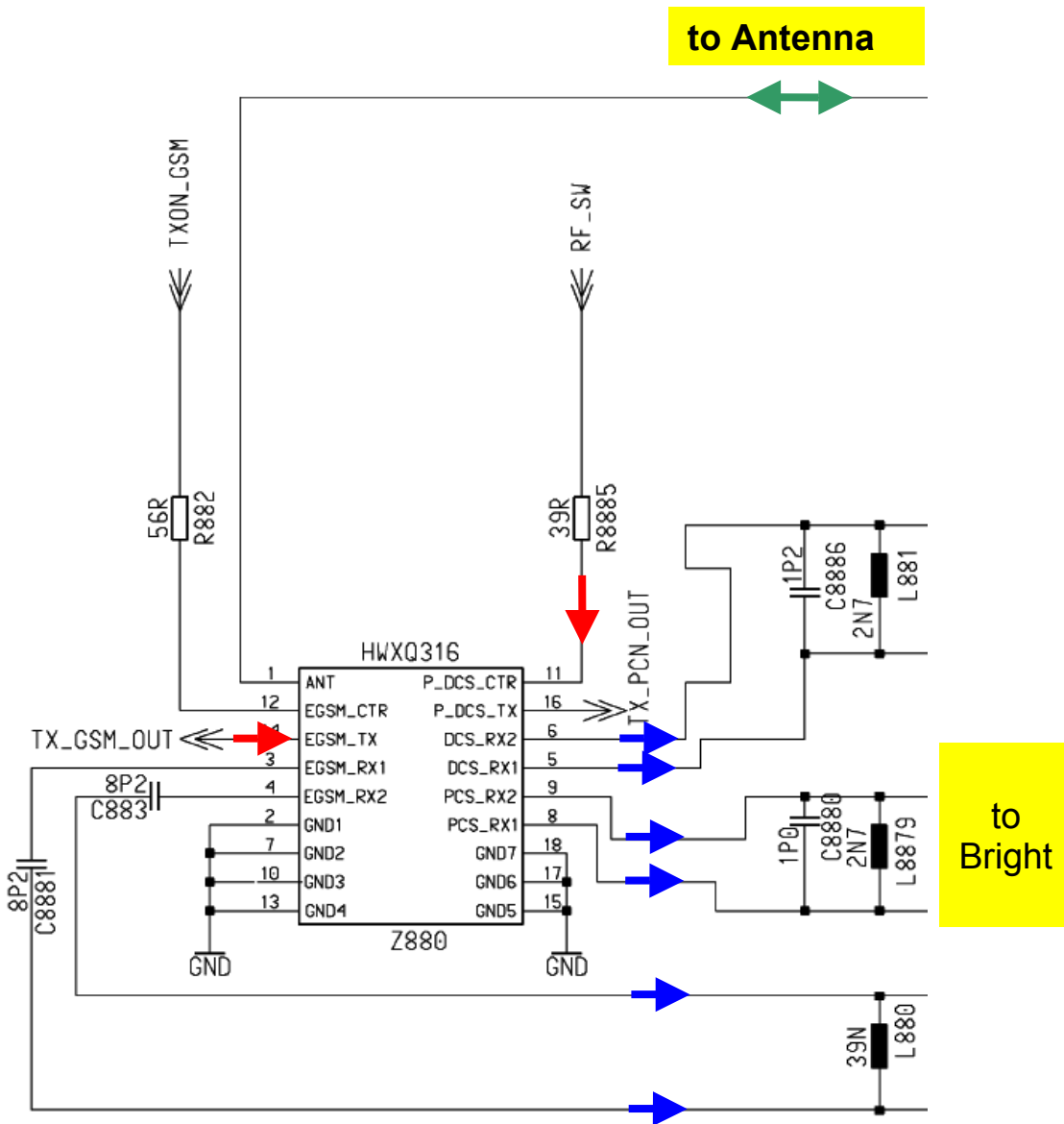
- The mechanical antenna switch for the differentiation between the internal and external antenna
- The electrical antenna switch, for the differentiation between the receiving and transmitting signals.
To activate the correct settings of this diplexer, the EGOLD+ signals **RF_SW** and **TXON_GSM** are required

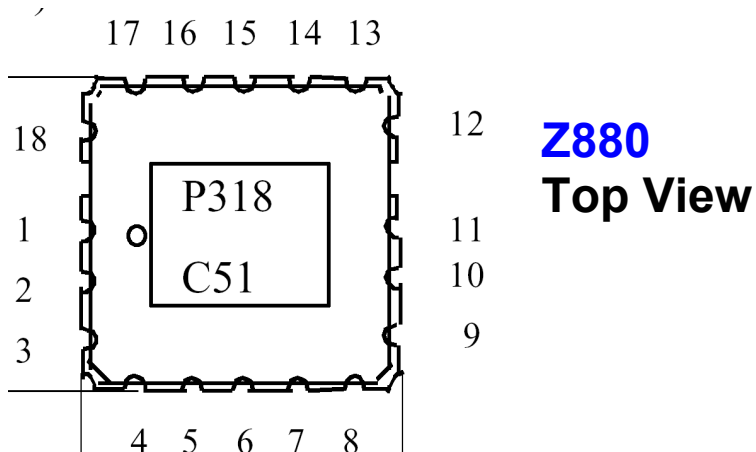
As a new feature the S55/S57 has an integrated "SAR detection" circuit. This circuit is used to decide if the internal antenna or an external antenna is used. The goal is, to reduce the transmit power when the internal antenna is used and the mobile is held very close to the body. On the other hand, the mobile can send with more power, if the external antenna is used. This distinction is done by the SAR detection circuit which consists of the voltage divider R872 and R873. The **ANT_DET** output provides a high level when the external antenna is used. **ANT_DET** (Serial Interface L16) is connected to the EGOLD+. Required voltage is **VCC_ANT_DET** (**VCC2_8** via **R892**)

- Internal/External antenna switch



b) The electrical antenna switch





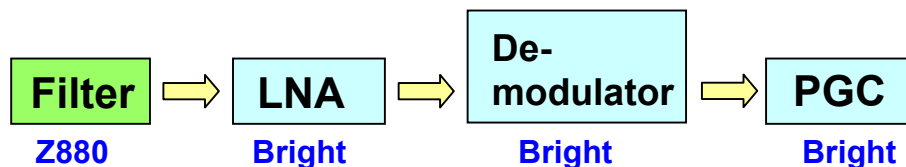
1	ANT	10	GND
2	GND	11	V _c (DCS)
3	EGSM-Rx1	12	V _c (EGSM)
4	EGSM-Rx2	13	GND
5	DCS-Rx1	14	EGSM-Tx
6	DCS-Rx2	15	GND
7	GND	16	DCS-Tx
8	NC	17	GND
9	NC	18	GND

		EGSM		DCS	
		Rx	Tx	Rx	Tx
V _c (EGSM)	0V	on	off	-	-
	2.5V (10mA)	off	on	-	-
V _c (DCS)	0V	-	-	on	off
	2.5V (10mA)	-	-	off	on

4.4 Receiver

4.4.1 Receiver: EGSM900/GSM1800/GSM1900 –Filter to Demodulator

From the antenna switch, up to the demodulator the received signal passes the following blocks to get the demodulated baseband signals for the EGOLD+:



Filter: The EGSM900, GSM1800 and GSM 1900 filters are located inside the frontend module. The Filter are centred to a frequency of 942,5MHz for EGSM900, 1847,5MHz for GSM1800 and 1960MHz for GSM1900. The symmetrical filter output is matched via LC-Combinations to the LNA input of the BRIGHT (D800)

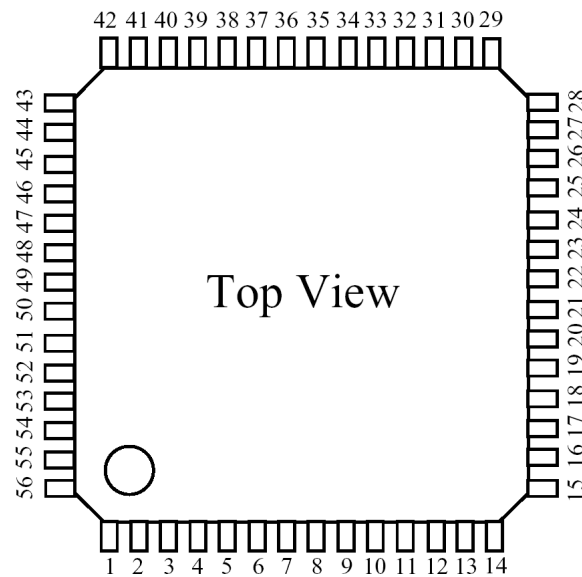
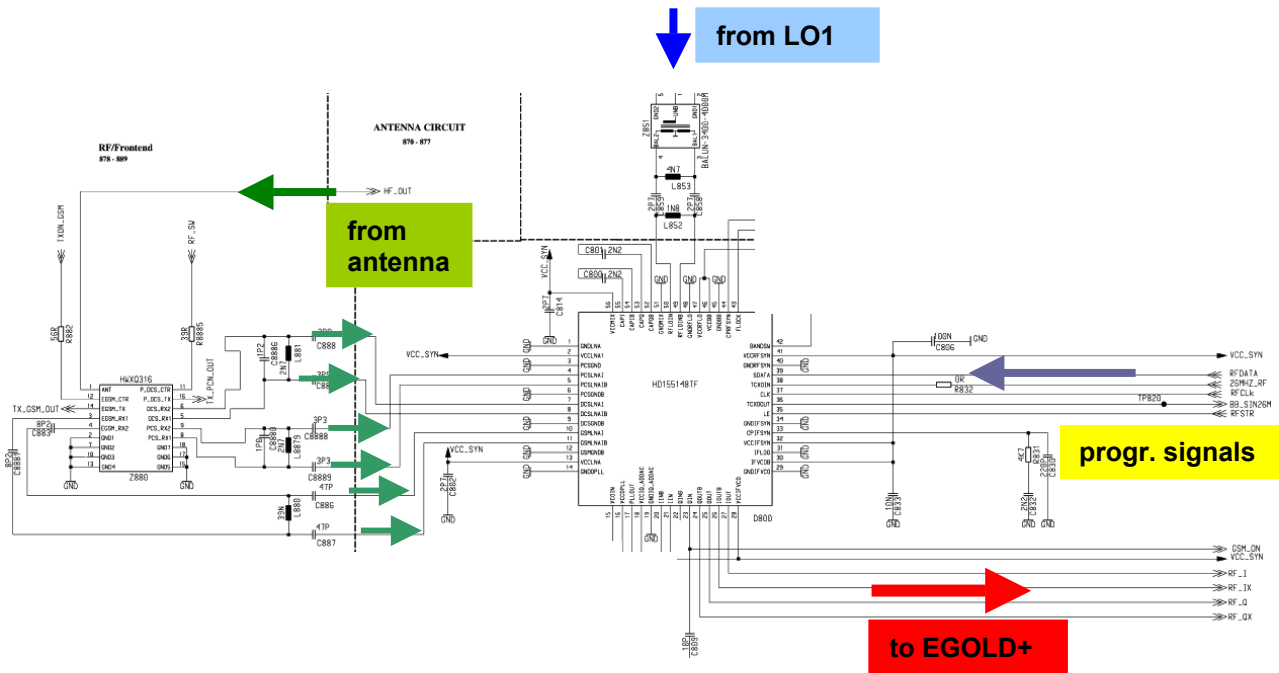
LNA: The 2 LNA's (EGSM900/GSM1800/GSM1900) are located inside the BRIGHT and are able to perform an amplification of ~ 20dB. The LNA can be switched in HIGH (On) and LOW (Off) mode and is controlled by the Bright depending on EGOLD+ information.

Demodulator: The Bright IC performs a direct demodulation of the received GSM signals. To do so the LO1 is required. The channel depending LO1 frequencies for 1800MHz/1900MHz bands are divided by 2 and by 4 for 900MHz band, Bright internally.

PGC: After demodulation the "I" and "Q" signals are amplified by the PGC-Amplifier the "I" and the "Q" path are amplified independently from each other. The performance of this PGC is 80dB (-26 up to 54dB), switchable in steps of 2dB. The control is realised through the EGOLD+ signals (RFDATA; RFCLK; RFSTR.(RF Control J15, J16, J17). After passing a Bright internal switch (necessary because of the double using of RX and TX lines), the signals are ready for further processing through the EGAIM (part of the EGOLD+) The post-switched logic measures the level of the demodulated baseband signal and regulates the level to a defined value by varying the PGA-Amplification and switching the appropriate LNA gains

The required voltage **VCC_SYN** is provided by the ASIC **D361**

Circuit diagram

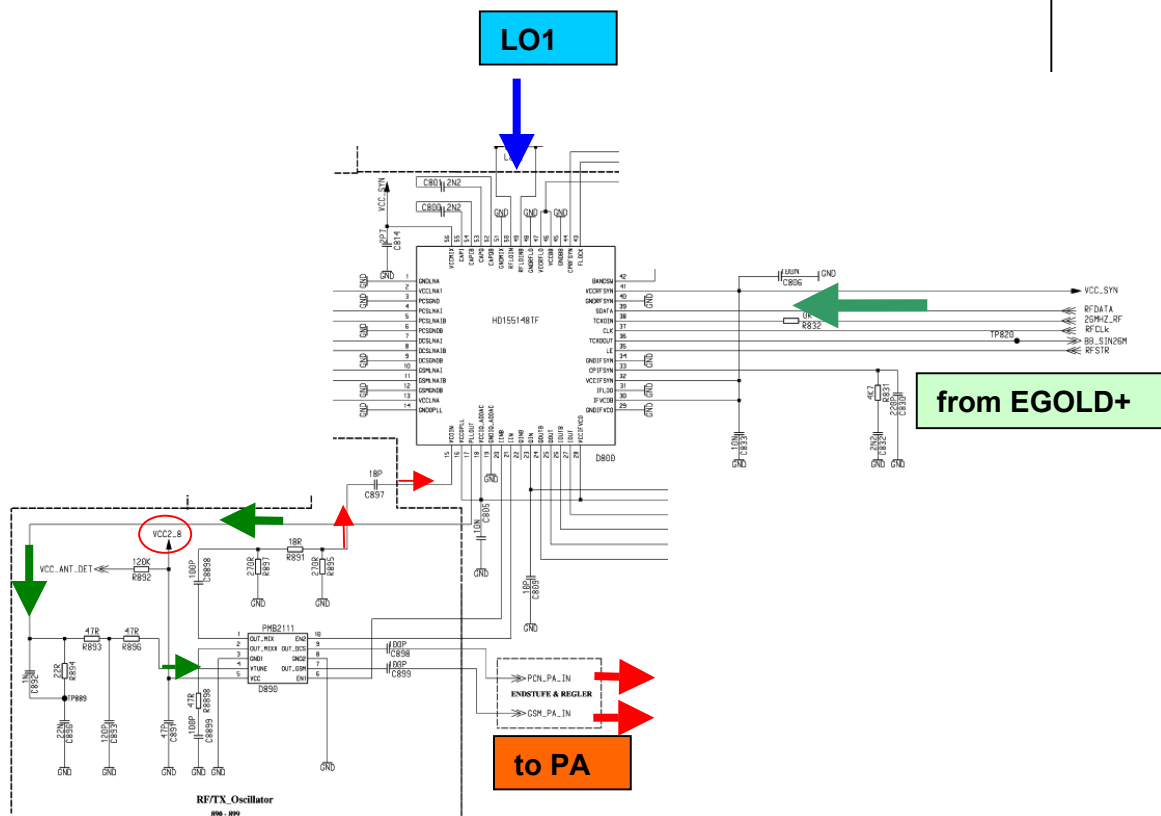


4.5 Transmitter

4.5.1 Transmitter: Modulator and Up-conversion Loop

The modulation is based on the principle of the “up-conversion modulation phase locked loop” and is accomplished via the BRIGHT IC(D800). An internal TX IF-LO provides the quadratic modulator with the TX IF frequency of 80/82 MHz by generating 640/656MHz divided by 8. This so generated IF GMSK RF signal is compared in a phase detector with the down mixed GMSK RF output from the TX-VCO (Z150). To get the comparison signal, **PCN_PA_IN** (for GSM1800/GSM1900), and **GSM_PA_IN** (for EGSM900) appearing at Pin 9/7 of the (D150) are mixed with the LO1 signal (divided by 2 for GSM1800/GSM1900 and 4 for EGSM900). The output (PLLOUT) signal of the phase detector passes a discrete loop filter realised by capacitors and resistors to set the TXVCO to required frequency. The large loop band width (~1,5MHz) guarantees that the regulating process is considerably quicker than the changes in the modulation signal.

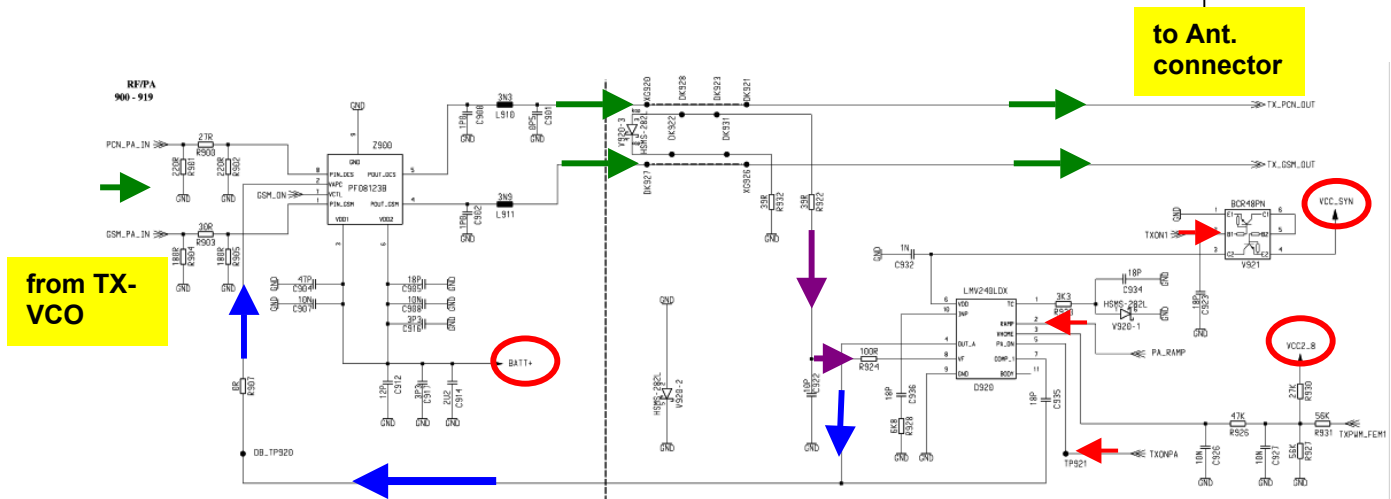
The required voltage **VCC_SYN** and **VCC2_8** is provided by the ASIC D361



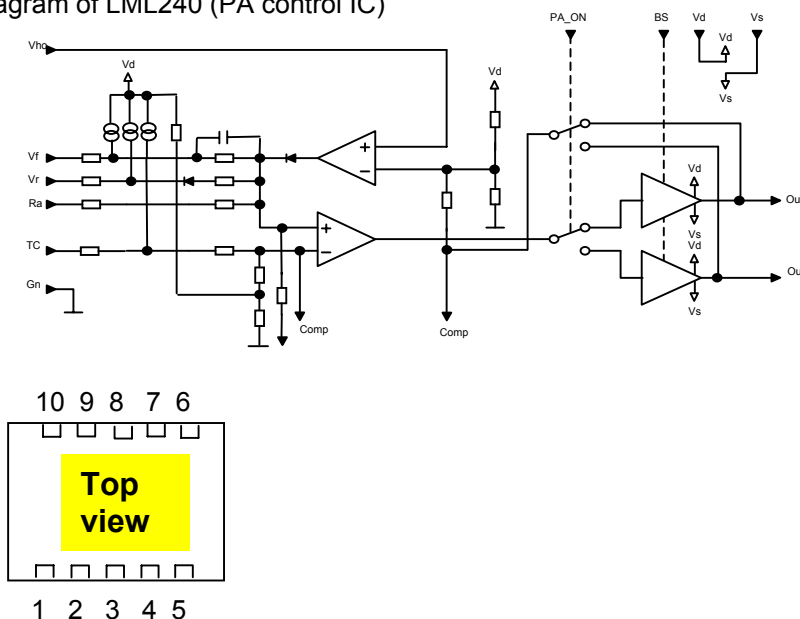
4.5.2 Transmitter: Power Amplifier

The output signals (PCN_PA_IN , and GSM_PA_IN) from the TX-VCO are led to the power amplifier (Z900) passing a matching circuit. The PA is a “two in one” PA (one for EGSM 900 and one for GSM1800 and GSM 1900) and is connected directly to BATT+. The band selection switching is done via GSM_ON from the Bright IC. After amplification, a part of the output signals (TX_PCN_OUT and TX_GSM_OUT) is decoupled via a directional coupler. The other part runs through the antenna switch (Z880) inside the FEM and the antenna connector (X870) to the antenna. The decoupled part is equalised by the detector diode (V920) and used from the RF-Power Regulator IC (D920) to get a PA control voltage, by comparing this voltage with the PA_RAMP signal provided from the EGOLD+ (analogue interface J2). The (N920) is activated through the signal TXON1. TXONPA enables with a “high” signal the output “a” (pin 4).

The required voltage BATT+ is provided by the battery.
The required voltage VCC2_8 is provided by the ASIC D361.



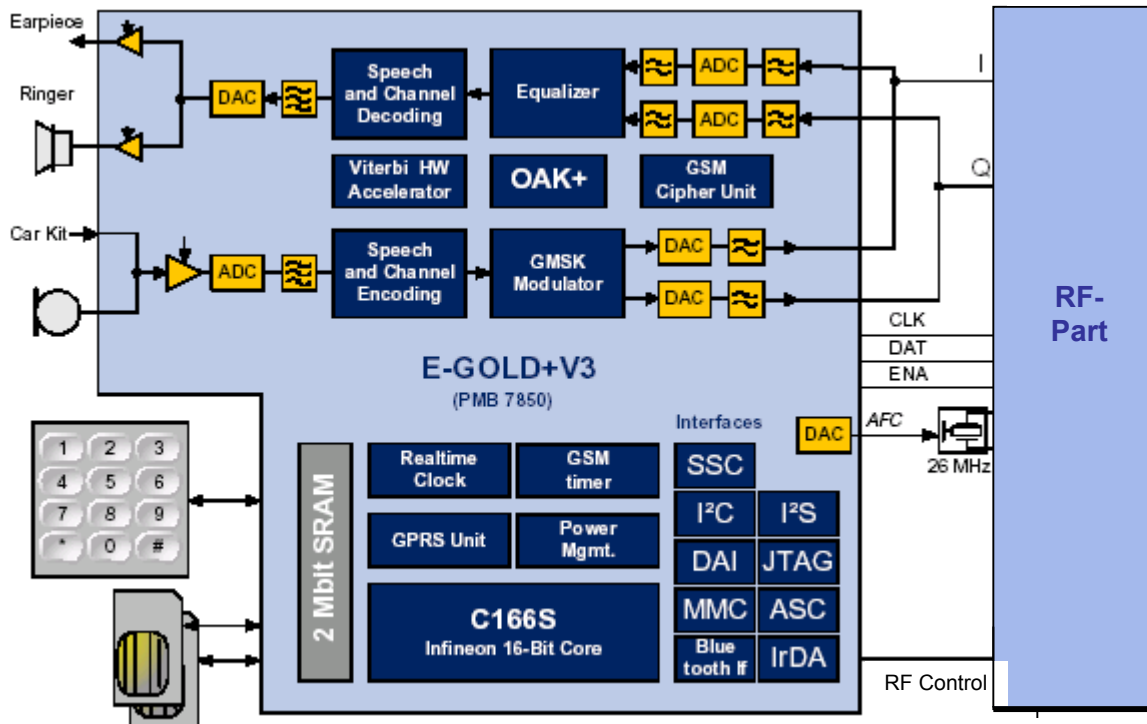
Blockdiagram of LML240 (PA control IC)



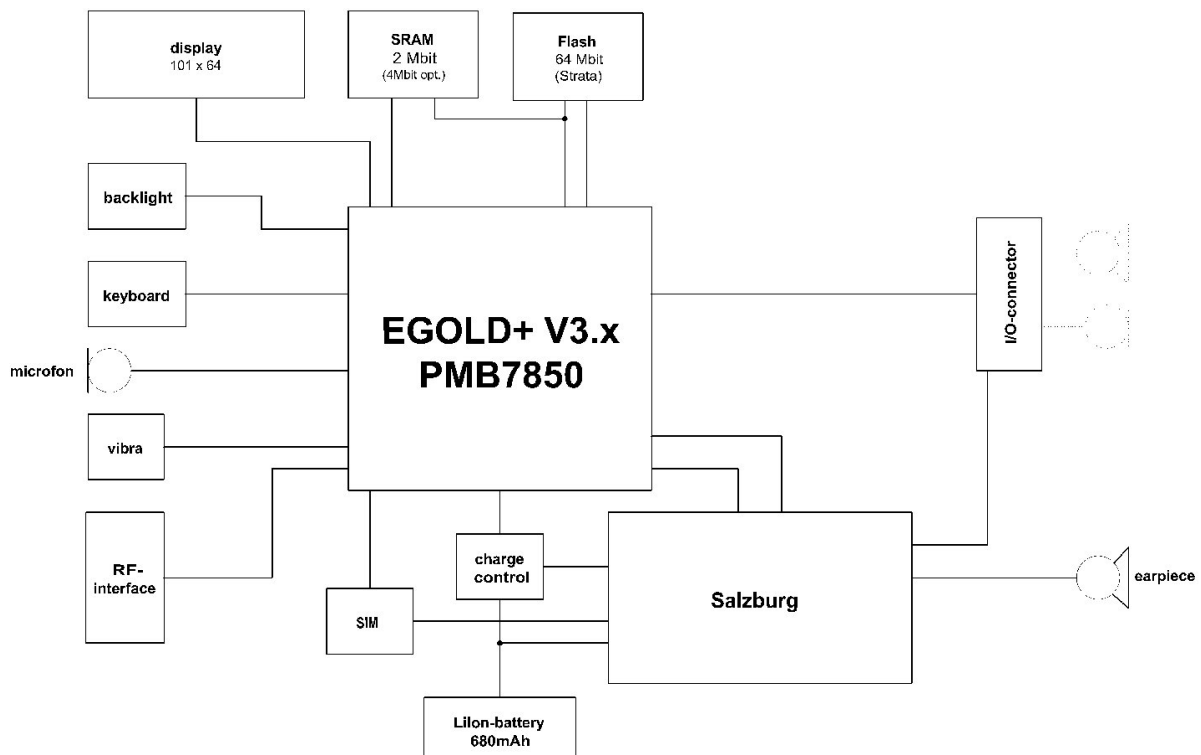
5 Logic / Control

5.1 Overview of Hardware Structure

5.1.1 Logic Block Diagram

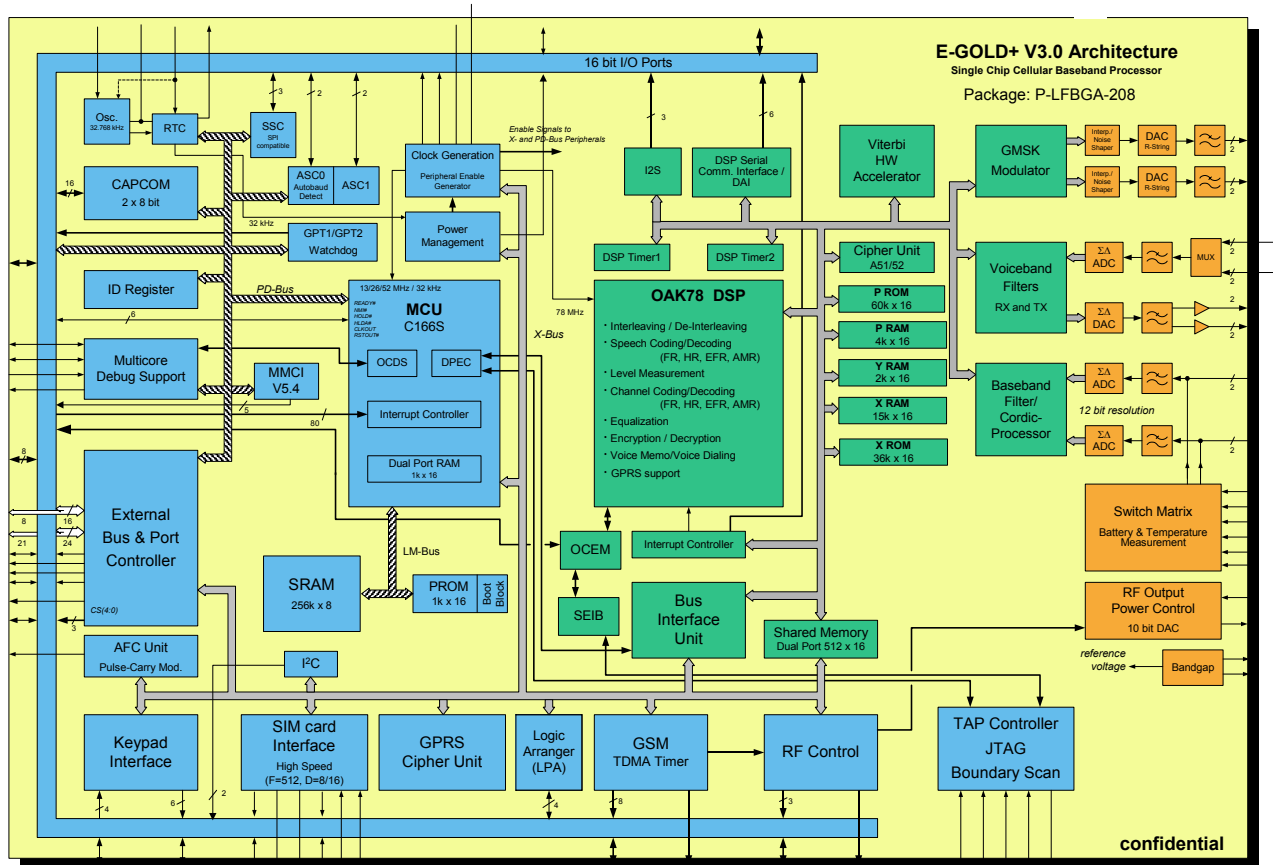


5.1.2 Block Diagram S55/S57 Control Part



5.1.3 EGOLD+

Block Diagram EGOLD+ V3.1



The **EGOLD+** contains a 16-bit micro-controller (μ C part), a GSM analog Interface (EGAIM), a DSP computing core (DSP part) and an interface for application-specific switch-functions.

The μ C part consists of the following:

- Micro-controller
- System interfaces for internal and external peripherals
- On-chip peripherals and memory

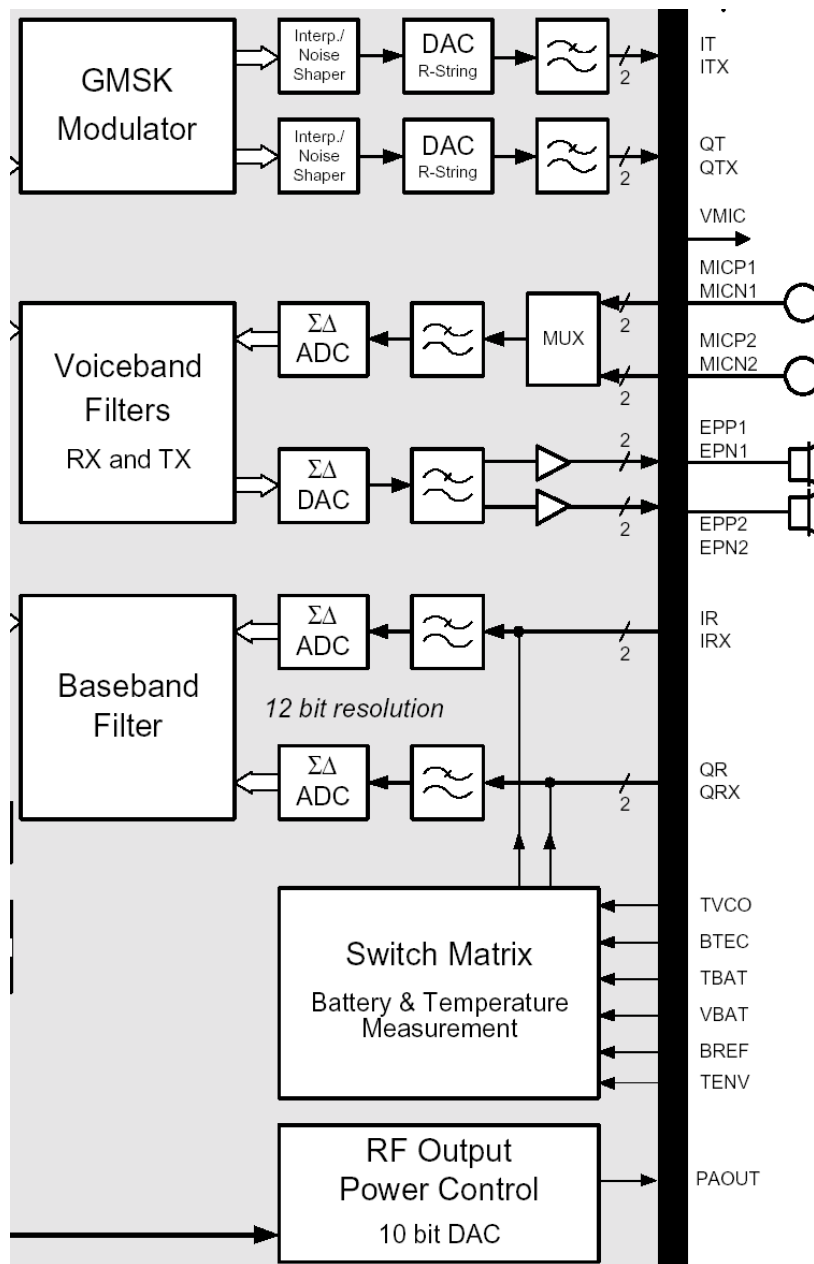
The Controller Firmware carries out the following functions:

- Control of the Man Machine Interface (keypad, LCD, sensing element, control of the illumination,...)
- GSM Layer 1,2,3 /GPRS
- Control of radio part (synthesizer, AGC, AFC, Transmitter, Receiver...),
- Control of base band processing (EGAIM)
- Central operating system functions (general functions, chip select logic, HW driver, control of mobile phones and accessories...).

The EGAIM part contains the interface between the digital and the analogue signal processing:

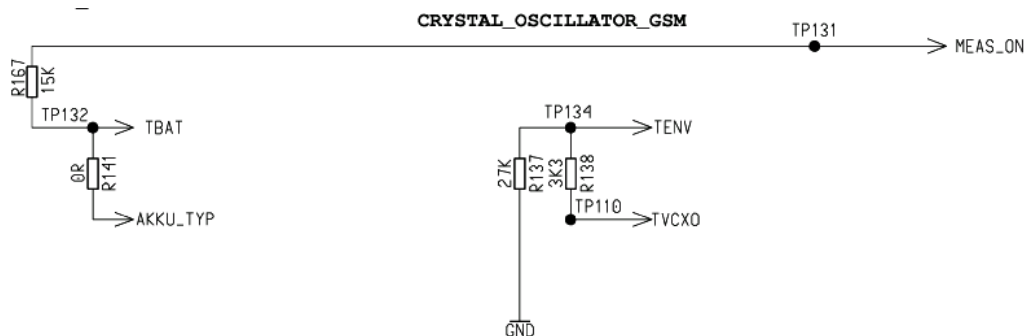
- 2 Sigma Delta A/D converters for RX signal, and for the necessary signals for the charge control and temperature measurement. For this, the converter inputs are switched over to the various signals via the multiplexer.
- 2 D/A converters for the GMSK-modulated TX signal,
- 1 D/A converter for the Power Ramping Signal,
- 1 Sigma Delta A/D and D/A converter for the linguistic signal.

Blockdiagram EGAIM inside the EGOLD



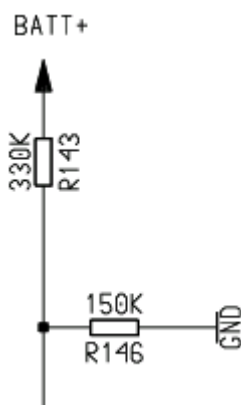
Measurement of Battery and Ambient Temperature

The battery temperature is measured via the voltage divider R1387, R138 by the EGOLD+ (Analog Interface P2). For this, the integrated $\Sigma\Delta$ converter of the RX-I base band branch is used. This $\Sigma\Delta$ converter compares the voltage of TBAT and TENV internally. Through an analogue multiplexer, either the RX-I base band signal, or the TBAT signal and the TENV signal is switched to the input of the converter. The signal MEAS_ON from the EGOLD+(GSM TDMA-TIMER H15) activates the battery voltage measurement. The ambient temperature TENV is measured directly at of the EGOLD+ (Analog Interface P3).



Measurement of the Battery Voltage

The measurement of the battery voltage is done in the Q-branch of the EGOLD+, for this BATT+ is connected via a voltage divider R143, R146 to the EGOLD+ (Analog Interface P1). An analogue multiplexer does the switching between the baseband signal processing and the voltage measurement.



A/D conversion of MIC-Path signals incl. coding

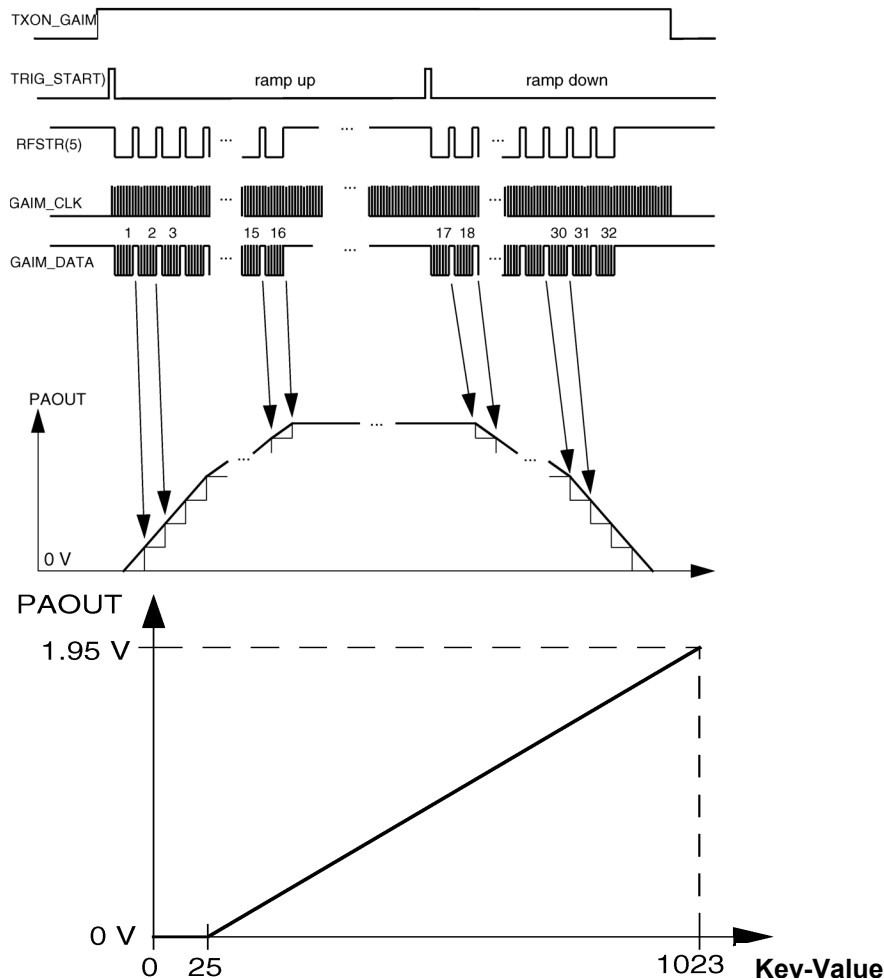
The Microphone signals (**MICN2**, **MIP2**, **MICP1**, **MICN1**) arrive at the voiceband part of the EGOLG+. For further operations the signals will be converted into digital information, filtered, coded and finally formed into the GMSK-Signal by the internal GMSK-Modulator. This so generated signals (**RF_I**, **RF_IX**, **RF_Q**, **RF_QX**) are given to the Bright IC in the transmitter path.

D/A conversion of EP-Path signals incl. decoding

Arriving at the baseband-Part the demodulated signals (**RF_I**, **RF_IX**, **RF_Q**, **RF_QX**) will be filtered and A/D converted. In the voiceband part after decoding (with help of the μ C part) and filtering the signals will be D/A converted amplified and given as (**EPP1_FIL**, **EPN1_FIL**) to the Power Supply ASIC.

Generation of the PA Control Signal (PA_RAMP)

The RF output power amplifier needs an analogue ramp up/down control voltage. For this the system interface on EGOLD+ generates 10 bit digital values which have to be transferred serially to the power ramping path. After loading into an 10 bit latch the control value will be converted into the corresponding analogue voltage with a maximum of $\sim 2V$



The DSP part contains:

- DSP signal processor
- Separate program/data memory
- a hardware block for processing the RX signal,
- a hardware block for “ciphers”,
- a hardware block for processing the linguistic signal,
- a hardware block for the “GMSK modulator”,
- De-/ interleaving memory,
- Communication memory
- a PLL for processing and reproducing the VCXO pulse signal.

In the DSP Firmware are implemented the following functions:

- scanning of channels, i.e., measurement of the field strengths of neighbouring base stations
- detection and evaluation of Frequency Correction Bursts
- equalisation of Normal Bursts and Synchronisation Bursts
- channel encoding and soft-decision decoding for fullrate, enhanced-fullrate and adaptive multirate speech, fullrate and halfrate data and control channels.
- channel encoding for GPRS coding
- fullrate, enhanced fullrate and adaptive multirate speech encoding and decoding
- mandatory sub-functions like
 - discontinuous transmission, DTX
 - voice activity detection
 - background noise calculation
- generation of tone and side tone
- hands-free functions
- support for voice memo
- support for voice dialling
- loop-back to GSM functions
- GSM Transparent Data Services and Transparent Fax
- calculation of the Frame Check Sequence for a RLP frame used for GSM NonTransparent Data Services
- support of the GSM ciphering algorithm

Real Time Clock (integrated in the EGOLD+):

The real time clock is powered via a separate voltage regulator inside the Power Supply ASIC. Via a capacitor, data are kept in the internal RAM during a battery change for at least 30 seconds. An alarm function is also integrated with which it is possible to switch the phone on and off.

5.1.4 SRAM

Memory for volatile data

Memory Size: 4 Mbit
Data Bus: 16Bit

5.1.5 FLASH

Memory Size: 64Mbit (8 Mbyte)
Data Bus: 16 Bit

5.1.6 SIM

SIM cards with supply voltages of 1.8V and 3V are supported.

5.1.7 Vibration Motor

The vibration motor is mounted in the lower case. The electrical connection to the PCB is realised with pressure contacts.

6 Power Supply

6.1 Power Supply ASIC

The power supply ASIC contains the following functions:

- Powerdown-Mode
- Sleep Mode
- Trickle Charge Mode
- Power on Reset
- Digital state machine to control switch on and supervise the μ C with a watchdog
- Voltage regulator
- Low power voltage regulator
- Additional output ports
- Voltage supervision
- Temperature supervision with external and internal sensor
- Battery charge control
- TWI interface
- I2C interface
- RC Oscillator
- Audio multiplexer
- Audio amplifier stereo/mono
- 18 bit Sigma/Delta DAC with Clock recovery
- Bandgap reference*

INFO:

* Bandgap reference

The p-n junction of a semiconductor has a bandgap-voltage. This bandgap-voltage is almost independent of changes in the supply voltage and has a very low temperature gradient. The bandgap-voltage is used as reference for the voltage regulators.

To reduce the power dissipation of the ASIC and to ensure high efficiency of the power management concept a DCDC Converter for the Core (EGOLD+V3 Baseband Chipset), Flash and SRAM supply is used.

The DCDC converter includes the following functions:

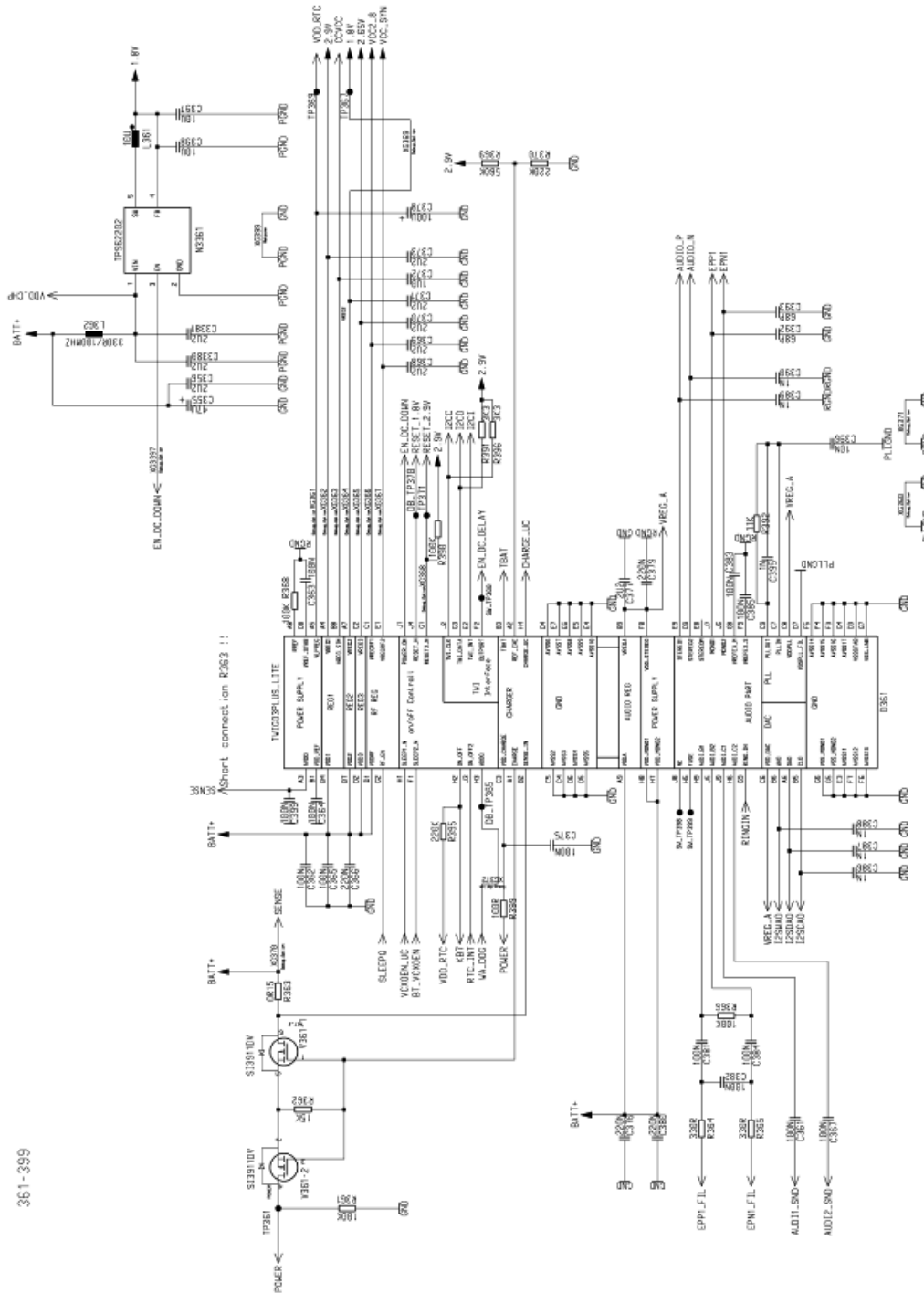
- PFM Mode for sleep mode of the Mobile Phone.
- PWM Mode for active mode of the Mobile Phone.

The mode change is controlled by the ASIC with the signal EN_DC_DOWN based on the EGOLD+ signal VCXO_EN.

6.1.1 Pinout diagram

9	8	7	6	5	4	3	2	1	
Vdda	vref	vreg2	dao	vlpreg	vreg1	avdd	ref_exe	charge	A
vrega	vregsim	vdd2	wao	clo	vdd1	tbat	sense_in	vddref	B
pllout	vddpll	pllin	Vdddac	VSS	VSS	vdd_charge	vreg3	vregrf1	C
stereoL	vref_stab	VSSPLL	VSS	VSS	VSS	VSSSTAB	vdd3	vddrf	D
stereoR	stereom	VSS	VSS	VSS	VSS	VSS	twi_int	vregrf2	E
Vrefex_s	vddstereo	VSS	VSS	VSS	VSS	VSS	outport	sleep2_n	F
ringin	vrefex_m	VSSLNB	VSS	VSS	VSS	twi_data	rf_en	reset2_n	G
audiob1	vddmono1	vddmono2	audioc2	lv_fuse	charge_uc	wdog_uc	on_off	sleep1_n	H
audioc1	audieat	mono1	mono2	audiob2	reset_n	on_off2	twi_clk	power_on	I

Step_Down



6.1.3 Power Supply Operating mode:

- Power Down Mode (mobile is switched off)

In power down mode the current consumption is very low. The inputs for switch on conditions (ON/OFF PinH2, ON/OFF2 PinJ3, VDD_CHARGE PinC3), the LPREG with his own voltage reference and POR cells are active. All other blocks are switched off, so the battery discharging will be kept to a minimum. This is the state when the phone is switched off.

- Start Up Mode (user switch on, RTC switch on)

"Start Up Mode" can be initiated by ON_OFF (falling edge) or ON_OFF2 (rising edge). In this mode a sequential start-up, of reference oscillator, voltage supervision and regulators is controlled by digital part. In case of failure (overvoltage or time out of the µC reaction), the ASIC shuts down.

-Trickle Charge Mode (to be able to charge the battery)

In case of a rising edge at VDD_CHARGE, the ASIC goes from power down to an interim state. In this state, the oscillator and the reference are started. If the voltage on VDD_CHARGE is below the charger detection threshold, the ASIC shuts off. If the voltage on VDD_CHARGE is high enough the signal EXT_PWR is going to H and the power up continues. Depending on the voltage of the battery an initial charging of the battery of the circuit is immediately done. If the Trickle Charge Mode is entered with a very low battery, the supply for the ASIC itself is generated from the internal VDDREF regulator. If a failure is detected (overvoltage), the ASIC is switched off.

- Normal Mode (following Start Up Mode or Trickle Charge Mode)

The normal mode is the situation, where the startup has been finished and the ASIC starts the external µC by changing the signal RESETN from low to high.

Mode: a) Active Mode with full capabilities of all blocks

b) Sleep Mode with reduced capabilities of some blocks and some even not available at all.

-Active Mode (submode of Normal Mode)

In this mode, the µC controls the charging block and most of the failure cases. The ASIC can be controlled by the TWI interface, interrupt request can be sent by the ASIC. Furthermore, the voltages are supervised (in case of failure the µC will be informed). In case of watchdog failure, overvoltage or power on request, the ASIC will be switched off immediately. The mono and the stereo block can be switched on in active mode.

-Sleep Mode (submode of Normal Mode)

Intention of the mode is to have a limited set of functions available with a reduced current consumption. A low level at the pin SLEEP1_N will switch from Active Mode to Sleep Mode. In Sleep Mode all charging functions and supply overvoltage detection are switched off. LDO undervoltage detection, clock and reference voltages are active. LDOs are working in low current mode. The battery voltage comparators are available, the audio block can be switched on.

6.1.4 Power Supply Functions:

- Power on Reset

To guarantee a defined startup, the ASIC will be reset by a Power on Reset block. After Power on Reset the ASIC will enter the power done Mode. If the thresholds will be reached during operating mode the reset will become the device enters the power down mode. This blocks are always active and will be supplied by **VDDREF**.

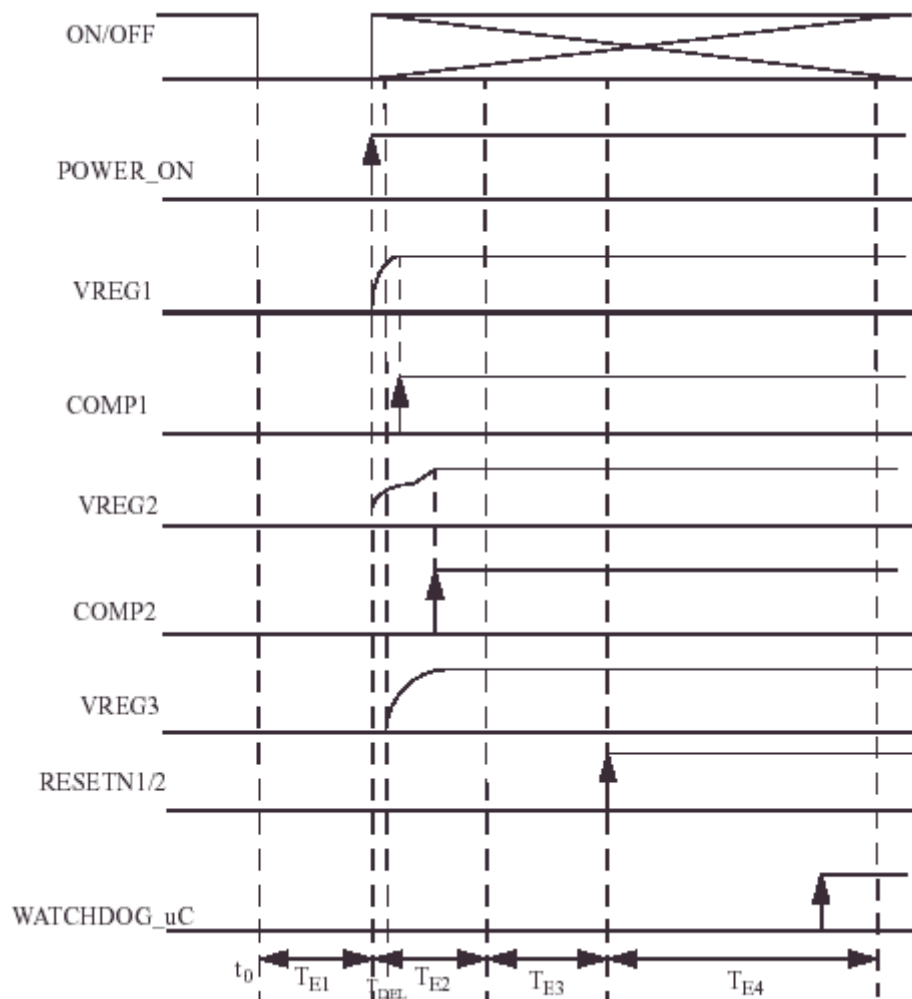
- Switch on and watchdog

There are 3 different possibilities to switch on the phone via external pins:

- VDD_CHARGE with rising edge
- ON/OFF with falling edge
- ON/OFF2 with rising edge

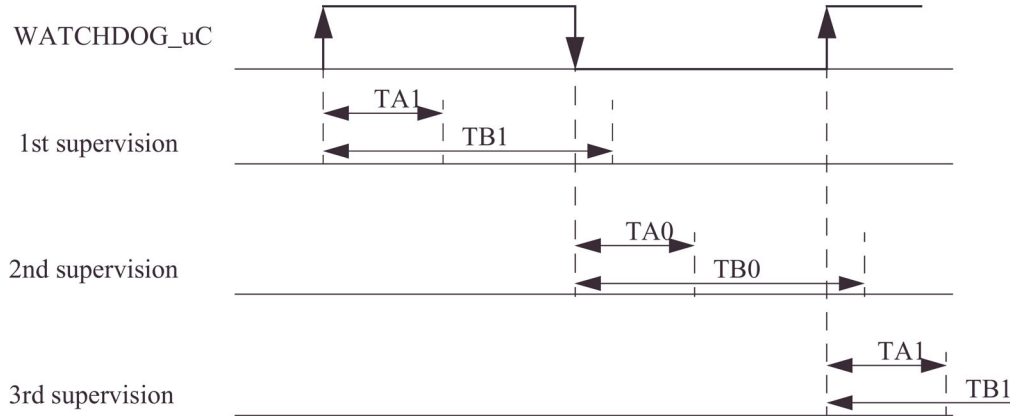
In order to guarantee a defined start-up behavior of the external components, a sequential power up is used and the correct start up of blocks is supervised. In normal mode, a continues watchdog signal from the μ C is needed to keep the system running. If this signals fails, the ASIC will switch to power down mode.

It must be guaranteed, that each start up condition does not interfere and block the other possible start up signals. In case of failure during start up, the device will go back to power down mode. To guarantee that the connection of the a charging unit with a very low battery is detected, this detection must work level sensitive at the end of POR signal.



- Watchdog monitoring

As soon as the first Watchdog_μC pin rising is detected, the device start the watchdog monitoring procedure. Standard switch off of the phone is the watchdog. The first edge of watchdog is rising. If a falling edge is detected ass the first transient the device will go to power down mode again and the whole phone is switched off.



Rising and falling edges must be detected alternated. With any edge on Watchdog_μC pin a counter will be loaded. The next – compared to the previous edge – inverted edge must occur between end of TA0,TA1 and end of TB0,TB1. If the signal occurs before end of TA0, TA1 or is not detected until end of TB0, TB1, the device will go to power down mode immediately after the violation of the WD criteria occurs.

TA0, TA1 ~ 0.4 sec

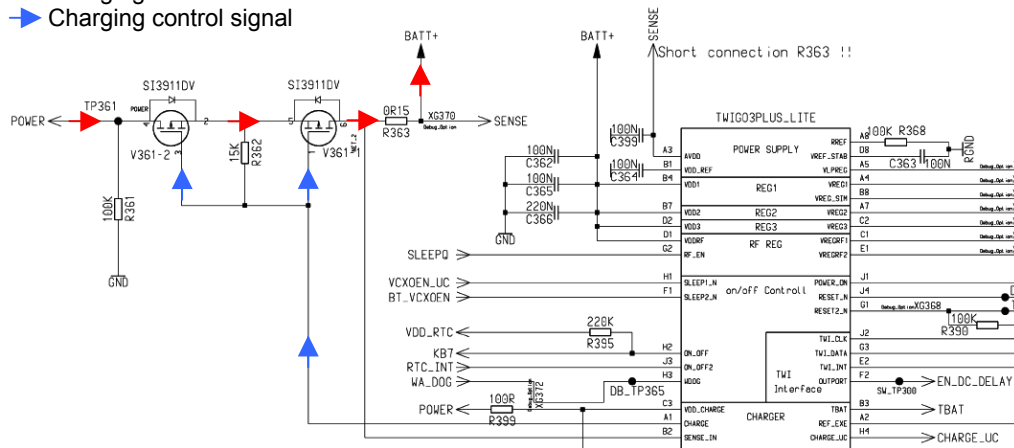
TB0, TB1 ~ 3 sec

6.2 Battery

As a standard battery a Lilon battery with a nominal capacity of 3,7 Volt/700mAh is used.

6.3 Charging Concept

- Charging current
- Charging control signal



6.3.1.1 Charging Concept

General

The battery is charged in the unit itself. The hardware and software is designed for Lilon with 4.2V technology.

Charging is started as soon as the phone is connected to an external charger. If the phone is not switched on, then charging takes place in the background (the customer can see this via the "Charge" symbol in the display). During normal use the phone is being charged (restrictions: see below).

Charging is enabled via a PMOS switch in the phone. This PMOS switch closes the circuit for the external charger to the battery. The **EGOLD+** takes over the control of this switch depending on the charge level of the battery, whereby a disable function in the **POWER SUPPLY ASIC** hardware can override/interrupt the charging in the case of over voltage of the battery (only for Manganese Chemistry Battery types e.g. NEC). With the new slim Lumberg IO connector we lose the charger recognition via SB line. Now we measure the charge current inside the **POWER SUPPLY ASIC** with a current monitor.

The charging software is able to charge the battery with an input current within the range of 350-600mA. If the Charge-FET is switched off, then no charging current will flow into the battery (exception is trickle charging, see below).

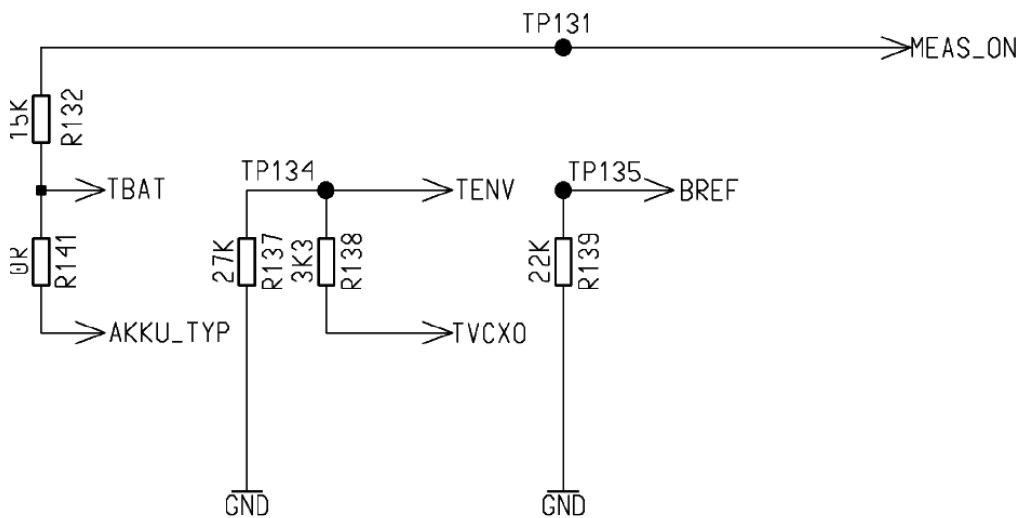
For controlling the charging process it is necessary to measure the ambient (phone) temperature and the battery voltage. The temperature sensor will be an NTC resistor with a nominal resistance of 22kΩ at 25°C. The determination of the temperature is achieved via a voltage measurement on a voltage divider in which one component is the NTC. The NTC for the ambient temperature will be on the PCB (26 MHz part).

Measurement of Battery, Battery Type and Ambient Temperature

The voltage equivalent of the temperature and battery code on the voltage separator will be calculated as the difference against a reference voltage of the **EGOLD**. For this, the integrated $\Sigma\Delta$ converter in the **EGOLD** of the RX-I base band branch will be used. Via an analogue multiplexer, either the RX-I base band signal, the battery code voltage or the ambient temperature voltage can be switched over to the input of the converter. The 1-Bit data stream of the converter will be subjected to a data reduction via the DSP circuit so that the measured voltage (for battery and ambient temperature) will be available at the end as a 10-bit data word.

Measurement of the Battery Voltage

Analogue to the I-branch either the RX-Q base band signal or the battery voltage can be measured in the Q-branch. Processing in the DSP circuit will be done analogue to the I-branch. The **EGOLD** will be specified internally at voltage measurement input **BATT+** for an input voltage of 3V...4.5V.



Timing of the Battery Voltage Measurement

Unless the battery is charging, the measurement is made in the TX time slot. During charging it will be done after the TX time slot. At the same time, either the battery temperature (in the I-branch) and the battery voltage (in the Q-branch) or the ambient temperature in the I-branch can be measured (the possibility of measurement in the Q-branch, the analogue evaluation of the battery coding, is used for HW-Coding). Other combinations are not possible. For the time of the measurement the multiplexer in the EGAIM must be programmed to the corresponding measurement.

Recognition of the Battery Type

The battery code is a resistor with a resistance depending on the manufacturer.

Charging Characteristic of Lithium-Ion Cells

Lilon batteries are charged with a U/I characteristic, i.e. the charging current is regulated in relation to the battery voltage until a minimal charging current has been achieved. The maximum charging current is approx. 600mA, minimum about 100mA. The battery voltage may not exceed $4.2V \pm 50mV$ average. During the charging pulse current the voltage may reach 4.3V. The temperature range in which charging of the phone may be started ranges from 5...40°C, and the temperature at which charging takes place is from 0...45°C. Outside this range no charging takes place, the battery only supplies current.

Trickle Charging

The **POWER SUPPLY ASIC** is able to charge the battery at voltages below 3.2V without any support from the charge SW. The current will be measured indirectly via the voltage drop over a shunt resistor and linearly regulated inside the **POWER SUPPLY ASIC**. The current level during trickle charge for voltages <2.8V is in a range of 20-50mA and in a range of 50-100mA for voltages up to 3.75V. To limit the power dissipation of the dual charge FET the trickle charging is stopped in case the output voltage of the charger exceeds 10 Volt. The maximum trickle time is limited to 1 hour. As soon as the battery voltage reaches 3.2 V the **POWER SUPPLY ASIC** will switch on the phone automatically and normal charging will be initiated by software (note the restrictions on this item as stated below).

Normal Charging

For battery voltages above 3.2 Volt and normal ambient temperature between 5 and 40°C the battery can be charged with a charge current up to 1C*. This charging mode is SW controlled and starts if an accessory (charger) is detected with a supply voltage above 6.4 Volt by the **POWER SUPPLY ASIC**. The level of charge current is limited/controlled by the accessory or charger.

USB Charging

For battery voltages above 3.2 Volt and normal Temperature between 5 and 40°C the battery can be charged with a charge current up to 1C. This charging mode is SW controlled and starts if an accessory (charger) with a supply voltage between 3.6 and 5.4 Volt is detected by the **POWER SUPPLY ASIC** during active mode of the phone. To enable this charging mode, the mobile phone must be registered (logged on) to a USB Host. The Charge-Only and Trickle-Charge Mode is not supported because of USB Spec. restrictions. The charge current is controlled by the **POWER SUPPLY ASIC**.

INFO:

* C-rate

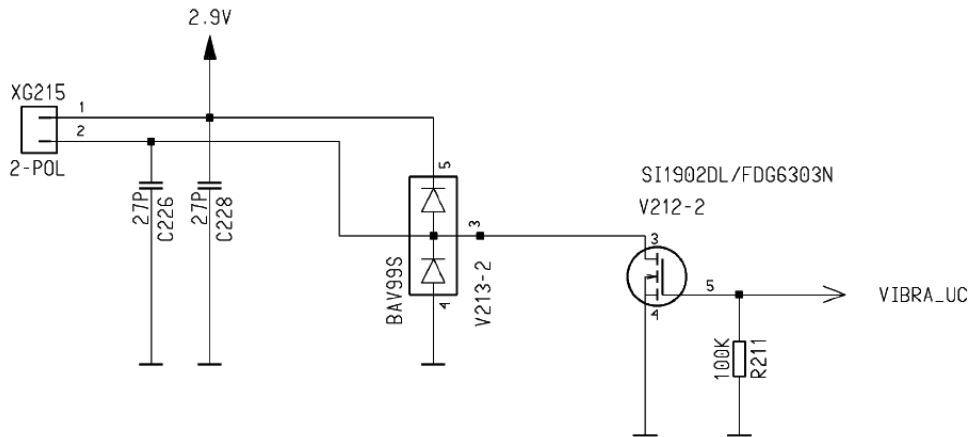
The charge and discharge current of a battery is measured in C-rate. Most portable batteries, are discharge with 1C. A discharge of 1C draws a current equal to the battery capacity. For example, a battery value of 1000mAh provides 1000mA for one hour if discharged at 1C. The same battery discharged at 0.5C provides 500mA for two hours. At 2C, the same battery delivers 2000mA for 30 minutes. 1C is often referred to as a one-hour discharge; a 0.5 would be a two-hour, and a 0.1C a 10 hour discharge.

Restrictions

- A battery which has completely run down can not be re-charged quickly because the battery voltage is less than 3.0V and the logic which implements the charge control cannot be operated at this low voltage level. In this case the battery is recharged via trickle-charging. However, the charging symbol cannot be shown in the display because at this time logic supply voltages are not operating. The charging time for this trickle-charging (until the battery can be fast-charged from then on) is in the range of 1 hour. If, within this time, the battery voltage exceeds 3.2V, then the **POWER SUPPLY ASIC** switches on the mobile and charging continues in the Charge-Only Mode. In some circumstances it can happen that after trickle-charging and the usually initiated switch-on procedure of the mobile, the supply voltage collapses so much that the mobile phone switches off again. In this case trickle charging starts again with a now raised threshold voltage of 3.75V instead of 3.2V, at maximum for 20 minutes. The **POWER SUPPLY ASIC** will retry switching on the phone up to 3 times (within 60 minutes overall).
 - Charging the battery will not be fully supported in case of using old accessory (generation '45' or earlier). It is not recommended to use any cables that adapt "old" to "new" Lumberg connector. Using such adapters with Marlin will have at least the following impact:
 - 1) half-sine wave chargers (e.g. P35 & home station) can not be used for trickle charging
 - 2) normal charging might be aborted before the battery is fully charged
 - 3) EMC compliance can not be guaranteed
 - A phone with a fully charged Lilon battery will not be charged immediately after switch-on. Any input current would cause an increase of the battery voltage above the maximum permissible value. As soon as the battery has been discharged to a level of about 95% (due to current consumption while use), it will be re-charged in normal charging mode.
 - The phone cannot be operated without a battery.
 - The phone will be destroyed if the battery is inserted with reversed polarity:
 - ⇒ design-wise it is impossible to wrongly pole the phone. This is prevented by mechanical means.
 - ⇒ electrically, a correctly poled battery is presumed, i.e. correct polarity must be guaranteed by suitable QA measures at the supplier
 - The mobile phone might be destroyed by connecting an unsuitable charger:
 - ⇒ a charger voltage >15V can destroy resistances or capacitors
 - ⇒ a charger voltage >20V can destroy the switch transistor of the charging circuit
- In case the transistor fails the ASIC will be destroyed. In the case of voltages lower than 15V and an improper current limitation the battery might be permanently damaged. A protection against grossly negligent use by the customer (e.g. direct connection of the charge contact to the electricity supply in a motor car) is not provided. Customer safety will not be affected by this restriction.

7 Interfaces

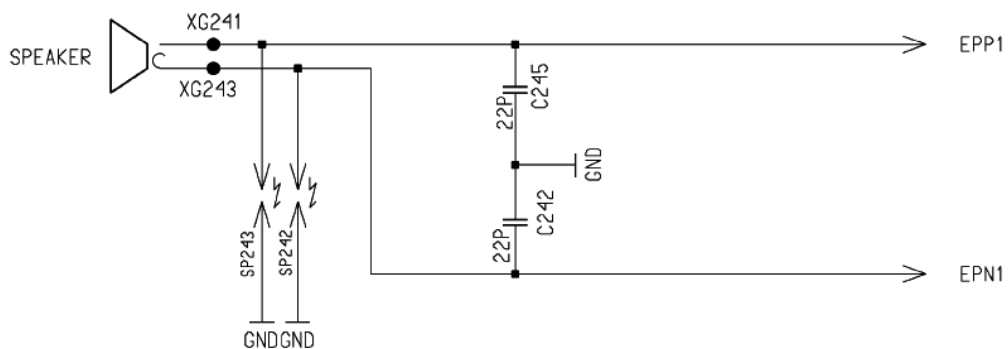
7.1 Vibra



XG215

Pin	IN/OUT	Remarks
1	I	2.9V
2	O	The FET V212 , switching this signal, is controlled via the EGOLD+ signal VIBRA_UC .

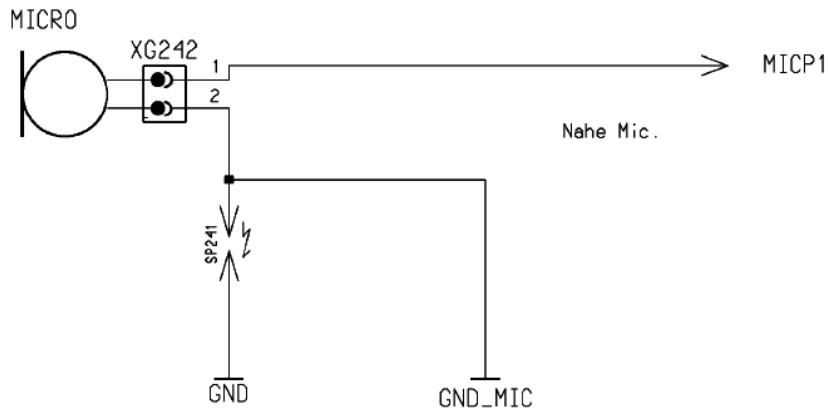
7.2 Earpiece



XG250

Pin	Name	IN/OUT	Remarks
1	EPP1	O	1st connection to the internal earpiece. Earpiece can be switched off in the case of accessory operation. EPP1 builds together with EPN1 the differential output to drive the multifunctional "earpiece" (earpiece, ringer, handsfree function).
2	EPN1	O	2nd connection to the internal earpiece. Earpiece can be switched off in the case of accessory operation.

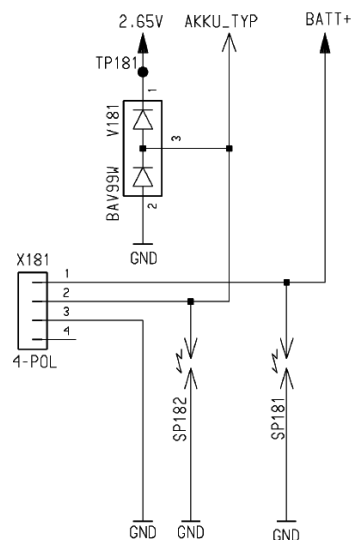
7.3 Microphone



XG242

Pin	Name	IN/OUT	Remarks
1	MICP1	I	Speech signal. The same line carries the microphone power supply.
2	GND_MIC		

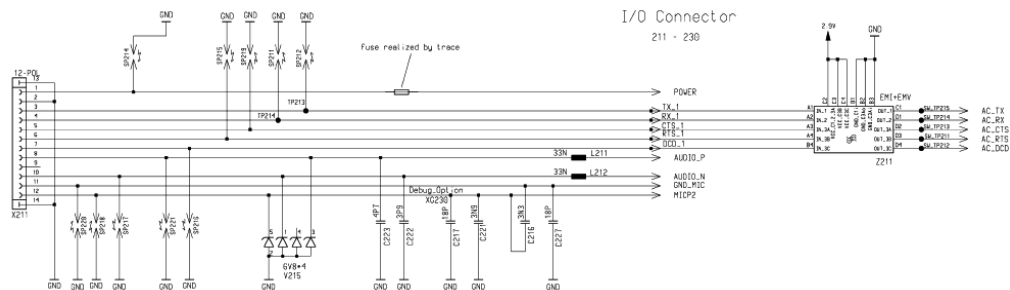
7.4 Battery



XG181

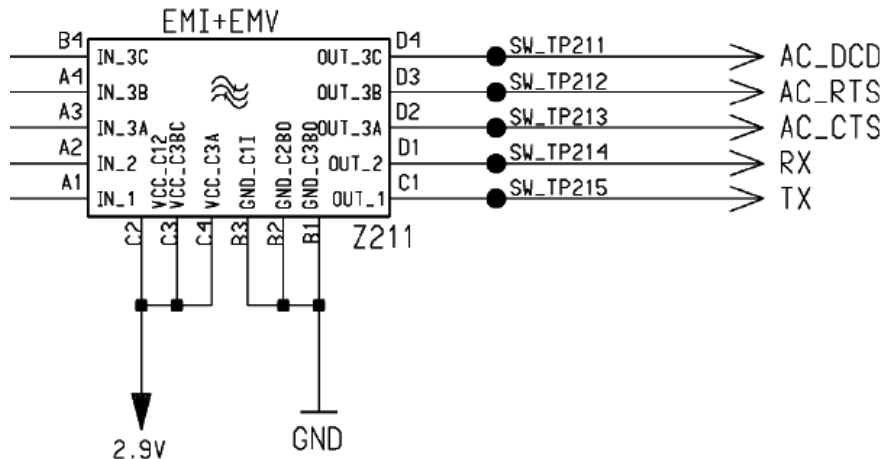
Pin	Name	Level	Remarks
1	GND		Ground
2	AKKU_TYP	0V...2.65V	Recognition of battery/supplier
3	BATT+	3 V... 4.5V	Positive battery pole
4			

7.5.1 IO Connector – New Slim Lumberg



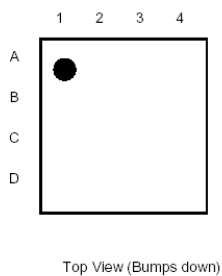
Pin	Name	IN/OUT	Notes
1	POWER	I/O	POWER is needed for charging batteries and for supplying the accessories. If accessories are supplied by mobile, talk-time and standby-time from telephone are reduced. Therefore it has to be respected on an as low as possible power consumption in the accessories.
2	GND		
3	TX	O	Serial interface
4	RX	I	serial interface
5	DATA/CTS	I/O	Data-line for accessory-bus Use as CTS in data operation.
6	RTS	I/O	Use as RTS in data-operation.
7	CLK/DCD	I/O	Clock-line for accessory-bus. Use as DTC in data-operation.
8	AUDIO_L	Analog O	driving ext. left speaker With mono-headset Audio_L and Audio_R differential mode
9			
10	AUDIO_R	Analog O	driving ext. right speaker With mono-headset Audio_L and Audio_R differential Signal
11	GND_MIC	Analog I	for ext. microphone
12	MICP2	Analog I	External microphone

7.5.2 ESD Protection with EMI filter



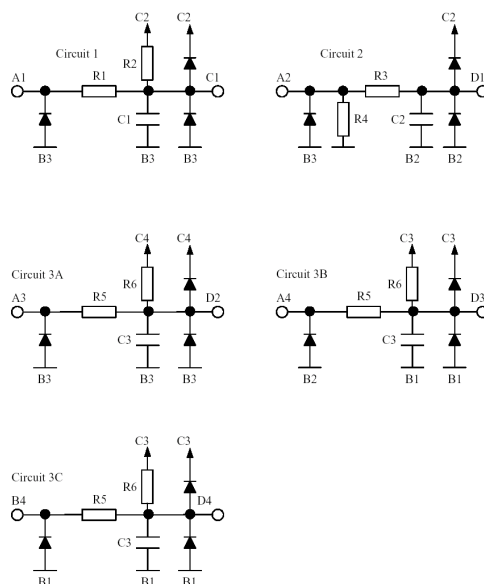
The **Z211** is a 5-channel filter with over-voltage and ESD Protection array which is designed to provide filtering of undesired RF signals in the 800-4000MHz frequency band. Additionally, the **Z211** contains diodes to protect downstream components from Electrostatic Discharge (ESD) voltages up to 8 kV.

Pin configuration of the **Z211**

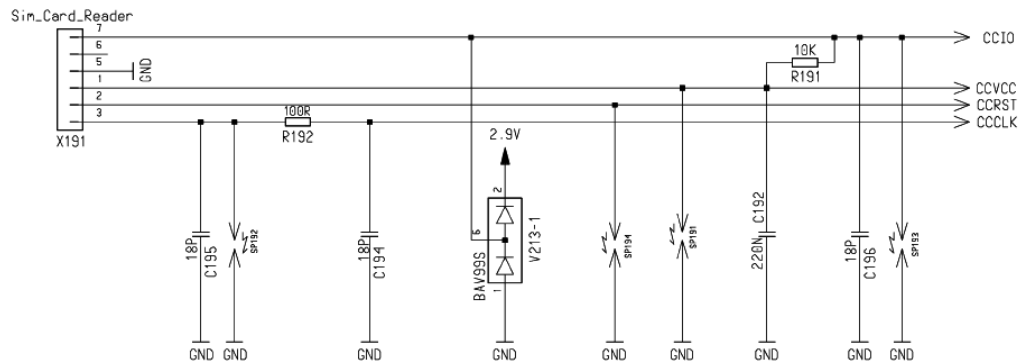


PIN	DESCRIPTION	PIN	DESCRIPTION
A1	Input Circuit 1	C1	Output Circuit 1
A2	Input Circuit 2	C2	Vcc C1/C2
A3	Input Circuit 3A	C3	Vcc C3B/C3C
A4	Input Circuit 3B	C4	Vcc C3A
B1	GND C3Bo/C3Ci/C3Co	D1	Output Circuit 2
B2	GND C2o/C3Bi	D2	Output Circuit 3A
B3	GND C1i/C1o/C2i/C3Ai/C3Ao	D3	Output Circuit 3B
B4	Input Circuit 3C	D4	Output Circuit 3C

Z211 Circuit Configuration

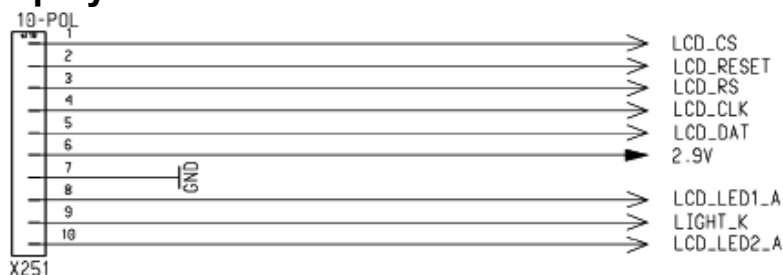


7.6 SIM



Pin	Name	IN/OUT	Remarks
1	CCVCC	-	Switchable power supply for chipcard; 220 nF capacitors are situated close to the chipcard pins and are necessary for buffering current spikes.
2	CCRST	O	Reset for chipcard
3	CCLK	O	Pulse for chipcard. The chipcard is controlled directly from the EGOLD+ .
4			
5	GND		
6			
7	CCIO	I	Data pin for chipcard; 10 kΩ pull up at the CCVCC pin

7.7 Display



Pin	Name	Remarks
1	LCD_CS	Chip select
2	LCD_RESET	Reset
3	LCD_RS	Register select
4	LCD_CLK	Clock
5	LCD_DAT	Data line
6	2.9V	Power supply display controller
7	GND	GND
8	LCD_LED2_A	Power supply display led 2
9	LIGHT_K	Switched GND for display led 1 and led 2
10	LCD_LED1_A	Power supply display led 1

8 Acoustic

The buzzer and the keypad clicks will be realized over the earpiece. At normal buzzer the signaling will realized with swelling tones. At the same time a maximum sound pressure level in the coupler of 135 +/- 5dB(A) is fixed.

The standard sounds will be generated by the **EGOLD+**, the advanced sounds will be generated via firmware running on the DSP.

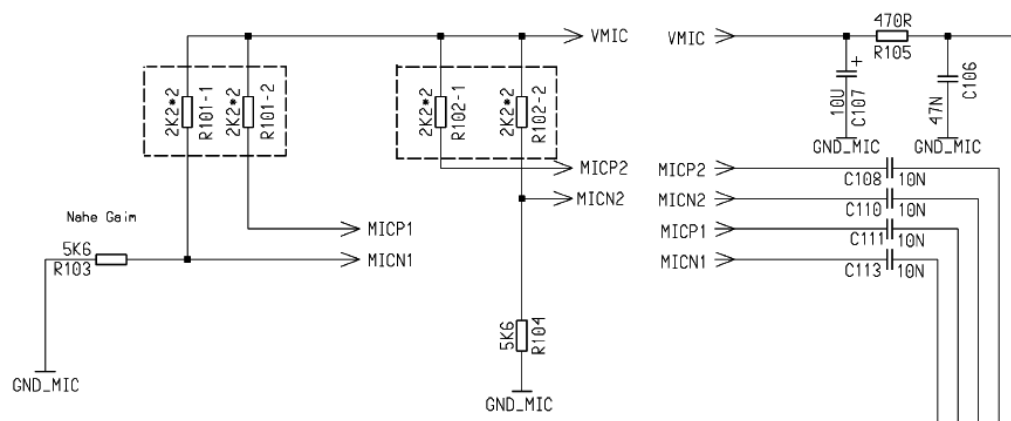
8.1 Microphone

8.1.1 Mechanical

The microphone is built in the Mounting Frame Lower Part and is mechanically fixed with a rubber seal (gasket). The contact on the PCB is realised via spiral springs, which are integrated in the gasket. Because of usage of Unidirectional Microphone, the gasket has a front- and a back sound-inlet hole. The front sound-inlet is acoustically tighten connected with a sound-inlet at the rear-side of the mounting frame lower part. The back sound-inlet is acoustically tighten connected with a sound-inlet at the bottom-side of the mounting frame lower part. The gasket of the microphone has a asymmetrical shape in order to provide non-rotating, guaranteed covering of the sound-inlets of mounting frame lower part to the corresponding sound-inlets at microphone gasket.

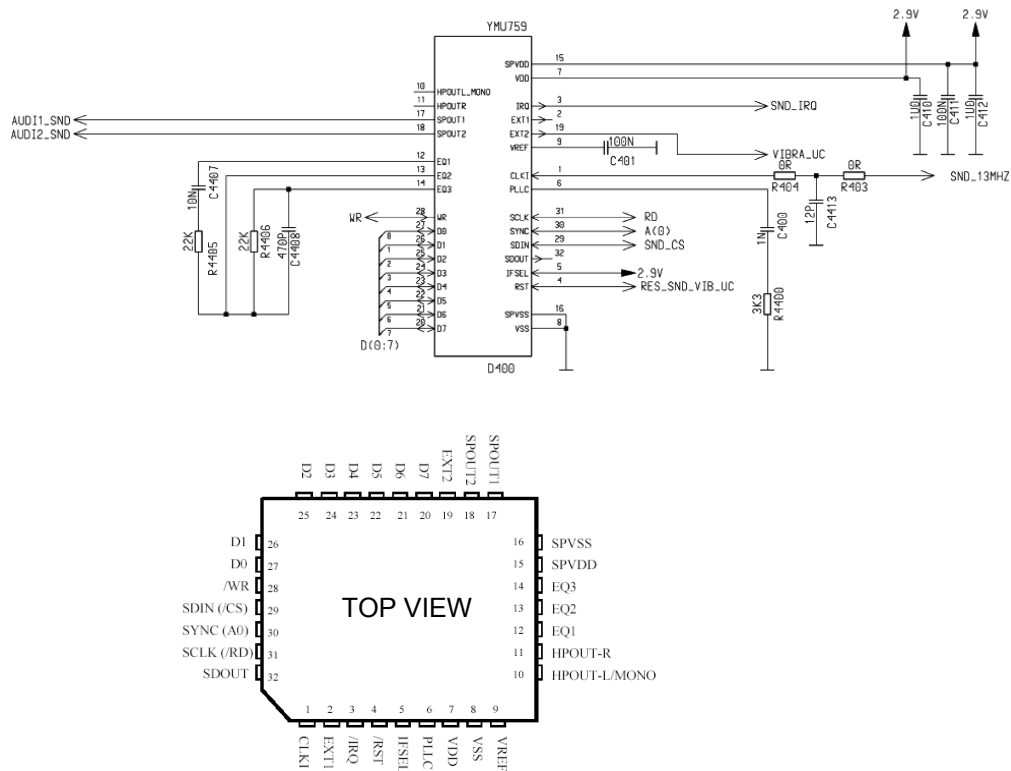
8.1.2 Electrical

Both Microphones are directly connected to the **EGOLD+**. (Analog Interface G2, F1-G3, H2) via the signals **MICN1**, **MICP1** (Internal Microphone)and **MICN2**, **MICP2** (External Microphone/Headset). Power supply for the Microphone is **VMIC** (**EGOLD+**. (Analog Interface G1))

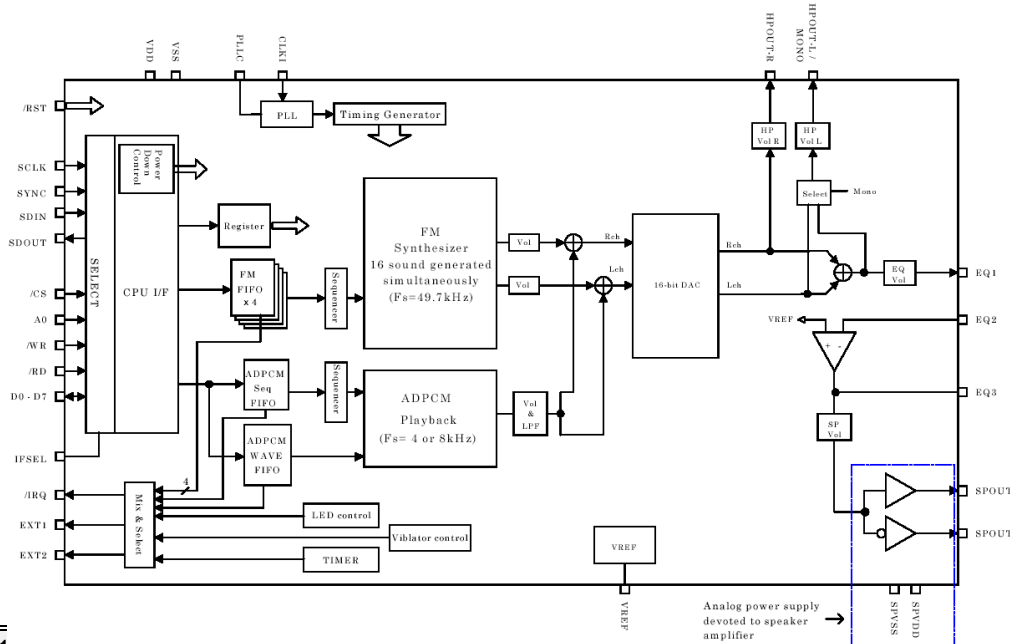


8.2 Soundchip

The **D400** is used for Stereophonic Sound Generation. The internal CPU receives the data from the **EGOLD+** via the address- and data- bus. Via a 16 sound FM synthesizer and DA converter the analogue output signal (AUDI1_SND, AUDI2_SND) goes to the audio amplifier inside the **Power Supply ASIC**. The clock for the D400 (SND_13MHZ/Miscellaneous U6) is made inside the **EGOLD+**, based of the 26MHZ VCO.



Blockdiagram



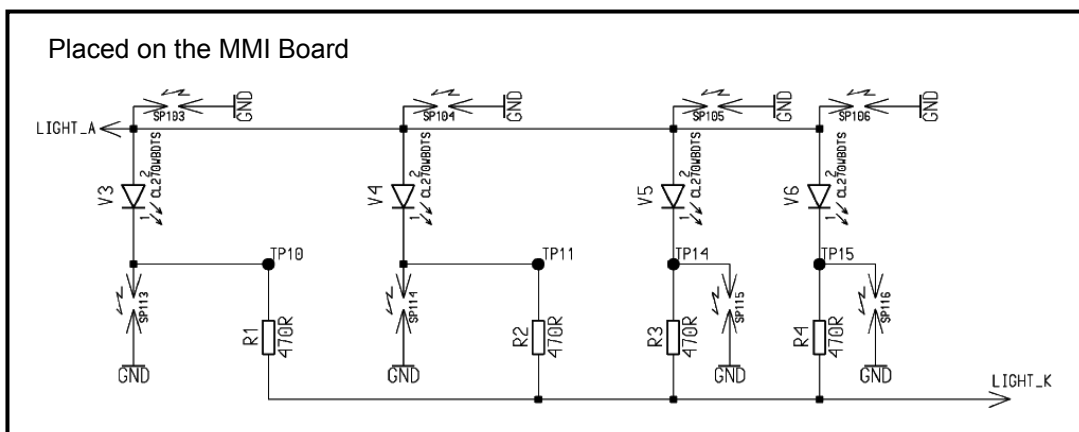
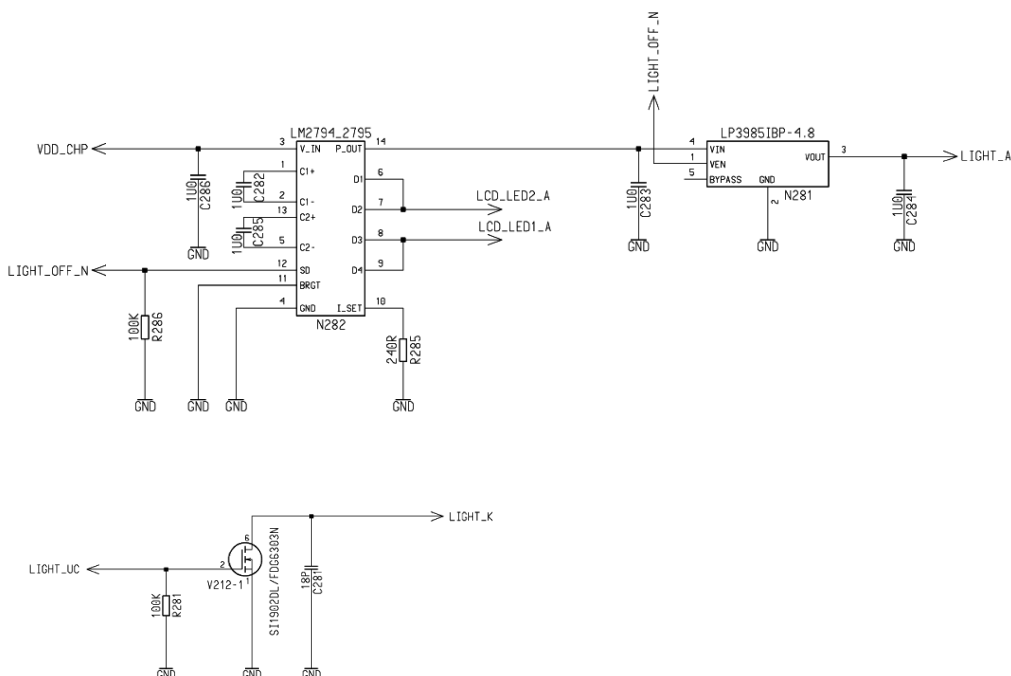
9 Display and Illumination

9.1 Display

The display is provided with 2,9V from the ASIC ([D361](#)). The communication with the EGOLD+ by the LCD-Signals, directly connected to the EGOLD+

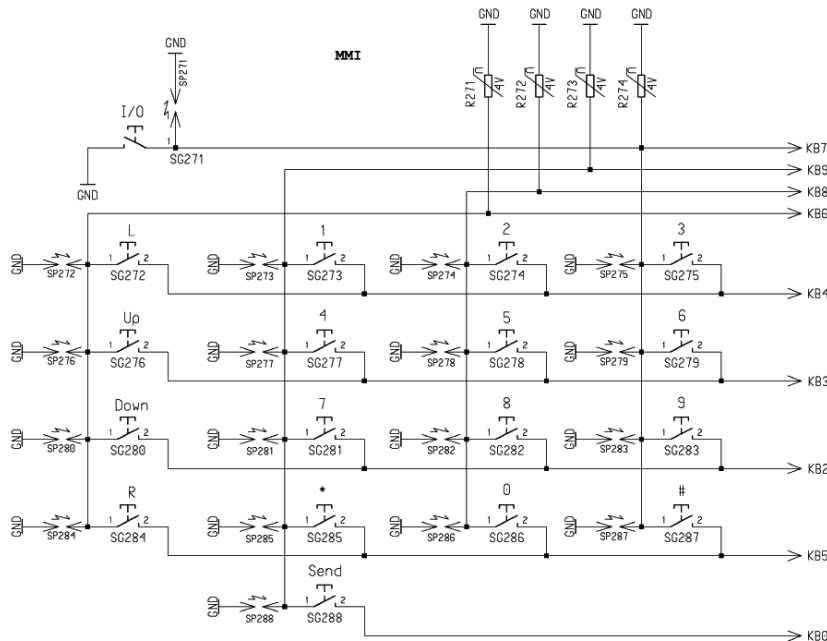
9.2 Illumination

The light is switched via switches inside the **EGOLD+**. With the signal **LIGHT_UC** (Miscellaneous T17) the illumination for the keyboard and the display backlight is controlled. With **LIGHT_OFF_N** (GSM TDMA-Timer G15) the illumination can be switched “on” and “off” during the TX timeslot.



10 Keyboard

The keyboard is connected via the lines KB0 – KB9 with the **EGOLD+**.
KB 7 is used for the ON/OFF switch. The lines KB0 – KB5 are used as output signals.
In the matrix KB6, KB8 and KB9 are used as input signals for the **EGOLD+**.



11 Bluetooth (only S55)

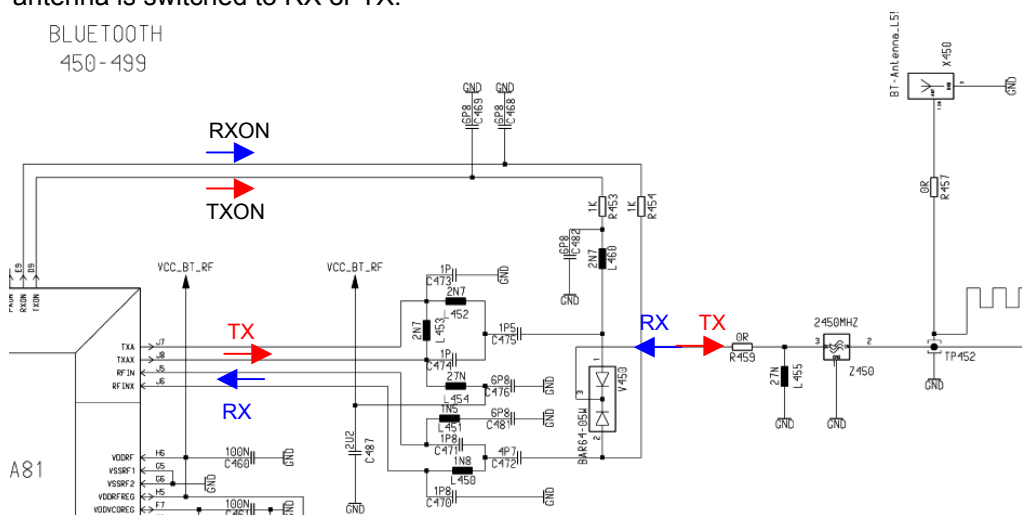
The Bluetooth Interface is compatible to the Bluetooth specification version 1.1 power class 2 (-6 dBm up to +4dBm) with a RX sensitivity better than -70 dBm. It supports a transmission rate up to 723 kBit/s data asymmetrically over the air interface.

The transmission range is approx. 10 m.

It is not possible to use the Bluetooth interface and the IRDA interface at the same time.

The Bluetooth antenna is via a pin diode switch connected with the **D450** (TX=J7, J8 and RX=J5, J6). With the signals RXON (D450, E9) and TXON (D450, D9) the antenna is switched to RX or TX.

BLUETOOTH
450-499

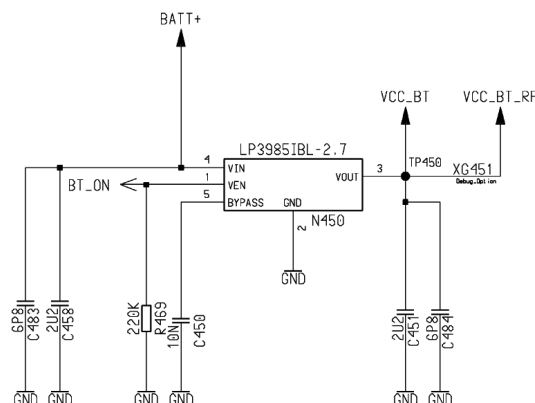


The following interface between E-GOLD+ and the BlueMoon Single Bluetooth IC (IFX) is used:

Name	IN/OUT	Remarks
Power supply		
VCC_BT	IN	Generated with external voltage regulator (LP3985) N450 VIN = BATT+
BT_ON	IN	Enable the voltage regulator
Clocks		
CLK32K	IN	32,768 kHz, (supplied by the EGOLD+)
BT_SIN26M	IN	Supplied by the GSM VCXO
UART		
IR_BT_TX	IN	TX (serial interface multiplexed with IRDA)
IR_BT_RX	OUT	RX (serial interface multiplexed with IRDA)
PCM		
PCMIN	IN	Transmission of voice samples DAI-interface from EGOLD+
PCMOUT	OUT	
PCMCLK	OUT	The 500 kHz clock is generated from BlueMoon Single
PCMFR	IN	The frame signal is generated from EGOLD+
Miscellaneous		
BT_WAKEUP_GSM	OUT	Connected to an interrupt input of EGOLD+, wake up EGOLD+ during Low power mode
BT_WAKEUP_BT	IN	Wake up the BlueMoon Single during Low power Mode
BT_VCXOEN		Connected to the ASIC, switched ON the RF-Regulator for the GSM-VCXO

11.1 Bluetooth Voltage Regulator

The Voltage Regulator N450 generates 2.7 Volt for the Bluetooth Chipset. The EGOLD+ activates the voltage with the signal BT_ON (GSM TDMA-Timer F17).



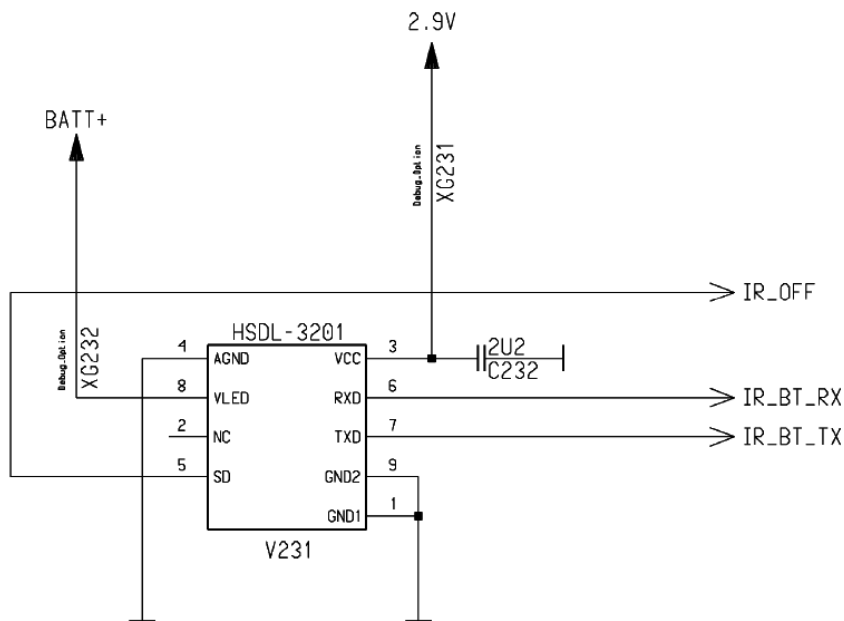
12 IRDA

Low-Power infrared data interface, compatible to "IRDA - Infrared Data Association; Serial Infrared Physical Layer Specification, Version 1.3", supporting transmission rates up to 115.2kbps (Slow IRDA). As a Low-Power-Device, the infrared data interface has a transmission range of at least:

- 20cm to other Low-Power-Devices and
- 30cm to Standard-Devices

The viewing angle is $\pm 15^\circ$ (resulting in 30° viewing cone).

It is not possible to use the IRDA interface and the Bluetooth interface at the same time.



Name	IN/OUT	Remarks
IR_OFF	IN	Activate IRDA
IR_BT_TX	IN	TX (serial interface multiplexed with Bluetooth)
IR_BT_RX	OUT	RX (serial interface multiplexed with Bluetooth)