7 - System Module

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Abbreviations

Abbr.	Description
ACI	Accessory Control Interface
ADC	Analog to digital converter
ASIC	Application Specific Integrated Circuit
ASIP	Application Specific Integrated Passive
ADSP	Application DSP (expected to run high level tasks)
ARM	Advanced RISC Machines
ARM915	ARM9TDMI Core, Caches, MMU’s
ARM925	ARM915 + WinCE Compatible MMU (WinCE is a hardwareprogrammed option which will not be enabled for Tiku.)
BB	Baseband
BB4.5	Common BaseBand 4.5 program
BC02	Bluetooth module by CSR
BL-8N	Battery type.
BlueBird	Bluetooth interface program to CSR.
CCP	Compact Camera Port
CDSP	Cellular DSP (expected to run low level tasks)
CIF	Common Intermediate Format (352x288 pixels)
COF	Chip on foil
COG	Chip On Glass
CP	Co-processor
CSR	Cambridge Silicon Radio
CSTN	Color Super Twisted Nematic
CTSI	Clock Timing Sleep and Interrupt block of Tiku
DCT4.5	Digital Core Technology, generation 4.5
DSP	Digital Signal Processor
DUT	Device under test
EMC	Electro Magnetic Compatibility
ESD	Electro Static Discharge

FR	Full Rate
FSTN	Film compensated Super Twisted Nematic
GSM	Global System Mobile
HW	Hardware
IF	Interface
IHF	Integrated Hands Free
IMEI	International Mobile Equipment Identity
IR	Infrared
IrDa	Infrared Data Association
LCD	Liquid Crystal Display
LDO	Low Drop Out
LED	Light Emitting Diode
LPRF	Low Power Radio Frequency
MCU	Microprocessor Control Unit
NTC	Negative temperature Coefficient, temperature sensitive resistor used as an temperature sensor.
PA	Power Amplifier (RF)
PDA	Personal Digital Assistant
PDRAM	Program/Data RAM (on chip in Tiku)
Phoenix	SW tool of DCT4.x
PUP	General Purpose IO (**P**IO), **U**SARTS and **P**ulse Width Modulators
PWB	Printed Wired Board
RHEA	TI bus from Lead3
RTC	Real Time Clock, small circuitry that keeps track of updating the clock counter and the calendar.
SARAM	Single Access RAM
SIM	Subscriber Identification Module
SW	Software
SWIM	Subscriber / Wallet Identification Module
TCXO	Temperature Controlled Chrystal Oscillator
Tiku	UPP (Universal Phone Processor), Official Tiku3G
TI	Texas Instruments, American company

UEME	Universal Energy Management Enhanced
UI	User Interface
USB	Universal Serial Bus
USWIM	UMTS Subscriber / Wallet Identification Module
USIM	UMTS Subscriber Identification Module
UPP	Universal Phone Processor
UPP_WD2	Communicator version of DCT4 system ASIC
VIA	Versatile Interface Architecture (on chip bus structure) Copper plated, drilled connection between layers in a PWB
WCDMA	Wide Band Code Division Multiple Access, Third Generation (3G) of Mobile Telephones
Zocus	Zero Ohm Current Sensor, Current measuring device. It measures the current from and to the battery. It is used by the EM SW for calculating the left over power in the battery.

General Description

Feature list

HW specific features:

- Monoblock phone
- Tripleband Engine (900, 1800, 1900)
- GPRS/EGPRS MSC 10 (4+1, 3+2)
- FR, EFR, AMR codecs
- Integrated VGA Camera
- Display: 208x104 pixels, transmissive and mirror (on film) effect
- MMS (Multi Media Messaging), Java MIDP2.0, SyncML1.1.1 and X-HTML
- Intergrated MP3 file support
- Bluetooth
- IR
- FM Radio
- IHF
- Rotator with limited UI input keys: Upper Soft Key, Lower Soft Key, SEND/END keys
- Mono (Plug'n'play) Accessory support
- Slide for receiving call
- Fixed battery

UI features

Bearers supported:

– EDGE

–CSD, HSCSD

–GPRS

–Bluetooth

Technical Specifications

These figures are a summary of the SPR-requirements.

Normal and extreme voltages

Following voltages are assumed as normal and extreme voltages for used battery:

Table 1: Normal and extreme voltages

Voltage	Voltage [V]	Condition
General Conditions		
Nominal voltage	3.90	a
Lower extreme voltage	3.3	b
Higher extreme voltage	4.30	c
HW Shutdown Voltages		
Vmstr+	2.1 ± 0,1	Off to on
Vmstr-	1.9 ± 0,1	On to off
SW Shutdown Voltages		
Sw shutdown	3.1	In call
Sw shutdown	3.2	In idle
Min Operating Voltage		
Vcoff+	3.1 ± 0,1	Off to on
Vcoff-	2.8 ± 0,1	On to off
HW-Reset Demands		
Min	1.0V	d
Max	--	

a. The nominal voltage is defined as being 15% higher than lower extreme voltage. TA will test with this nominal voltage at an 85% range (0.85 x 3.9V ª 3.3V)

b. This limit is set to be above SW shutdown limit in TA.

c. During fast charging of an empty battery, this voltage might exceed this value. Voltages between 4.20 and 4.60 might appear for a short while

d. The minimum Battery cell voltage required for the reset circuitry to turn on. This is not confirmed by measures at pt..

Temperature conditions

(1) Operational temperature range (all specifications met within this range)
–10°C +55°C[1]

(2) Functional temperature range (Reduced performance)
–30°C +70°C

(3) Storage temperature range:
–30°C +85°C

Temperatures at –10°C, +25°C and +55°C are used for cpk analysis.

The baseband module complies with the SPR4 Operating Conditions.

Humidity

Relative humidity range is 5...95%.

The BB module is not protected against water. Condensed or splashed water might cause malfunction. Any submerge of the phone will cause permanent damage. Long-term high humidity, with condensation, will cause permanent damage because of corrosion.

The baseband module complies with the SPR4 Operating Conditions.

Vibration

The baseband module complies with the SPR4 Operating Conditions.

ESD strength

The baseband module complies with the SPR4 Operating Conditions.

HW Architecture Description

GSM Cellular Engine

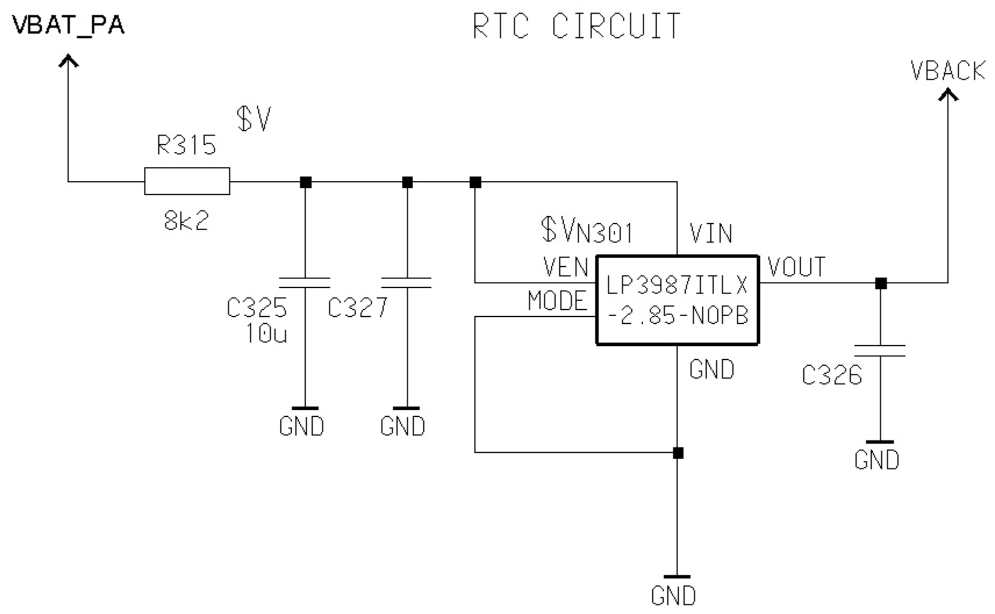
The BaseBand Engine consists of the TEMS (TikuEdge Memory Stacked Package) concept and UEMEK. The TEMS concept combines all memory components in one package, which is stacked on top of the TikuEdge. The memory combines 128Mbit NOR Flash, 512Mbit NAND Flash and 128Mbit SDRAM in one package. The TikuEdge is also implemented in a stacked package in which all pin connections are available on bottom pinout, and memory interface on top pin out (POP I/F).

The energy manegement related part of the microBB4.5 engine is the UEMEK.

RTC Circuitry

Therefore a voltage regulator is used to supply the RTC circuit via the battery. The circuit looks as follows:

Figure 1: RTC supply circuit



This is used in sleep mode where it is able to source 3mA. The supply VBAT_PA is bypassing the HW switch, and therefore will have contact to the battery also when the SIM drawer is pulled out.

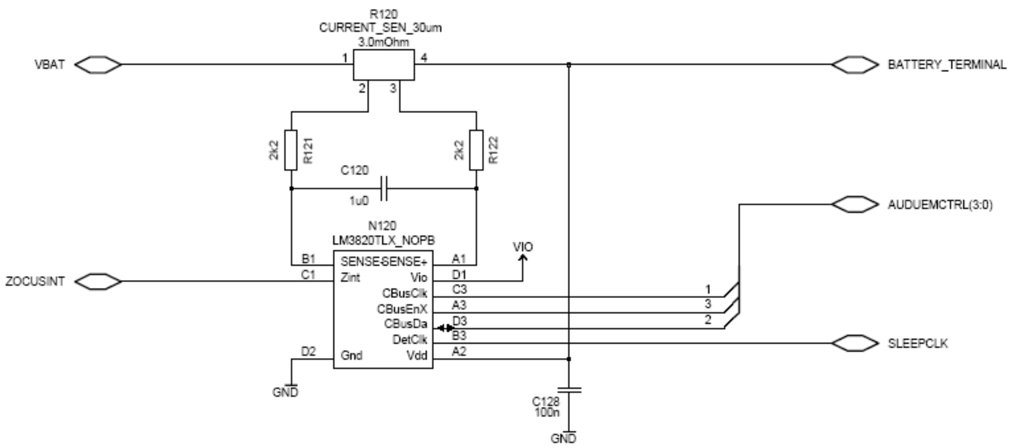
The circuit will give a long back up time. Capacity on the battery when it has been discharged to engine cut off (3,1V) is still 2.2mAh before battery voltage reaches 2,9V. This gives a back up time of approx:

71 hours.

Zocus

The Zocus device (LM3820) is a precision current sensor, used by energy management software to determine the current consumption in the mobile phone.

Figure 2: Zocus Circuit



Power Management

HW reset switch

Since the RM-14 project is equipped with a “fixed battery”, a need of a specific HW reset solution is required, since this is no longer possible by removing the battery. This request is meet by the implementation of a power cut-off switch that disconnects the battery power from the rest of the phone. This switch is implemented by 2 P-Channel MOSFET’s inserted in the battery power line.

RTC backup:

A minimum of 10 minutes power supplied to the RTC circuit is required.

Dead battery charge:

A battery safety circuit is protected by battery cell, which must be re-enabled.

Description:

The circuit depicted in HW Reset circuit-figure is connected to battery at “VBAT” and to the phone at VBAT_OUT. The switch referred to as “SW” illustrates the switch, which enables power, supplied to the phone. This is implemented as a normally open switch in the SIM can. Its function is to open when SIM-card is inserted and close whenever it’s extracted.

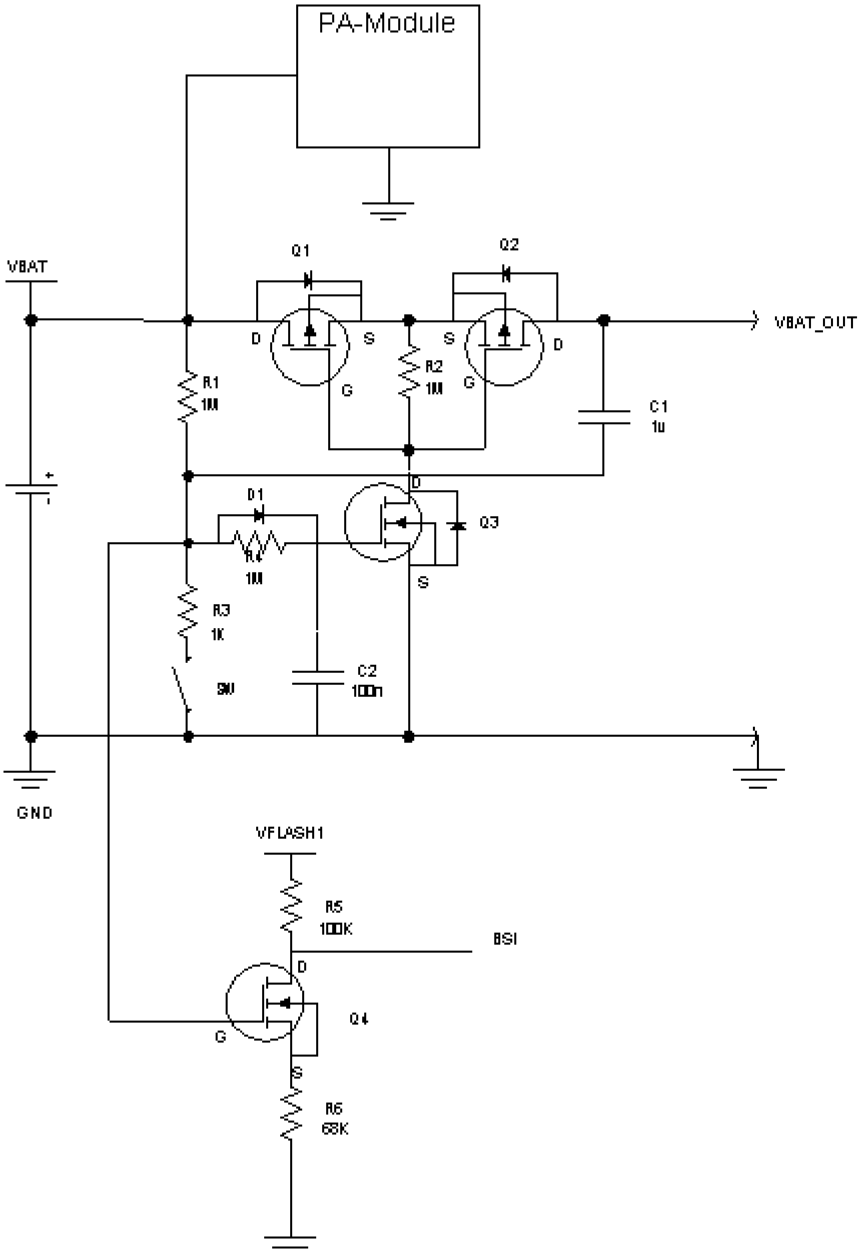
Beside of the PA-Module implementation, the rest of the phone will be powered from the VBAT_OUT.

Safety protected battery mode

This mode implies a battery that has its cell disconnected from battery terminals by the batteries own protection circuit .

When the protection circuit is disabled, the battery cell voltage is visible at the battery terminals. This means that the voltage of VBAT_OUT equals the battery cells whereas this must be higher than the Gate-Source threshold voltage of Q1-2.

Figure 3:HW Reset circuit



UEMEK

The UEMEK is providing the power for the phone. It consist of the following regulators:

– BB 8 voltage regulators

– RF 7 voltage regulators, 2 current regulators

The BB regulators in the UEMEK are controlled by MCUSW except VANA, VFLASH1, VIO, which are controlled by the UEMEK itself. The RF regulators are controlled by DSPSW except VR3, which is controlled by the UEMEK.

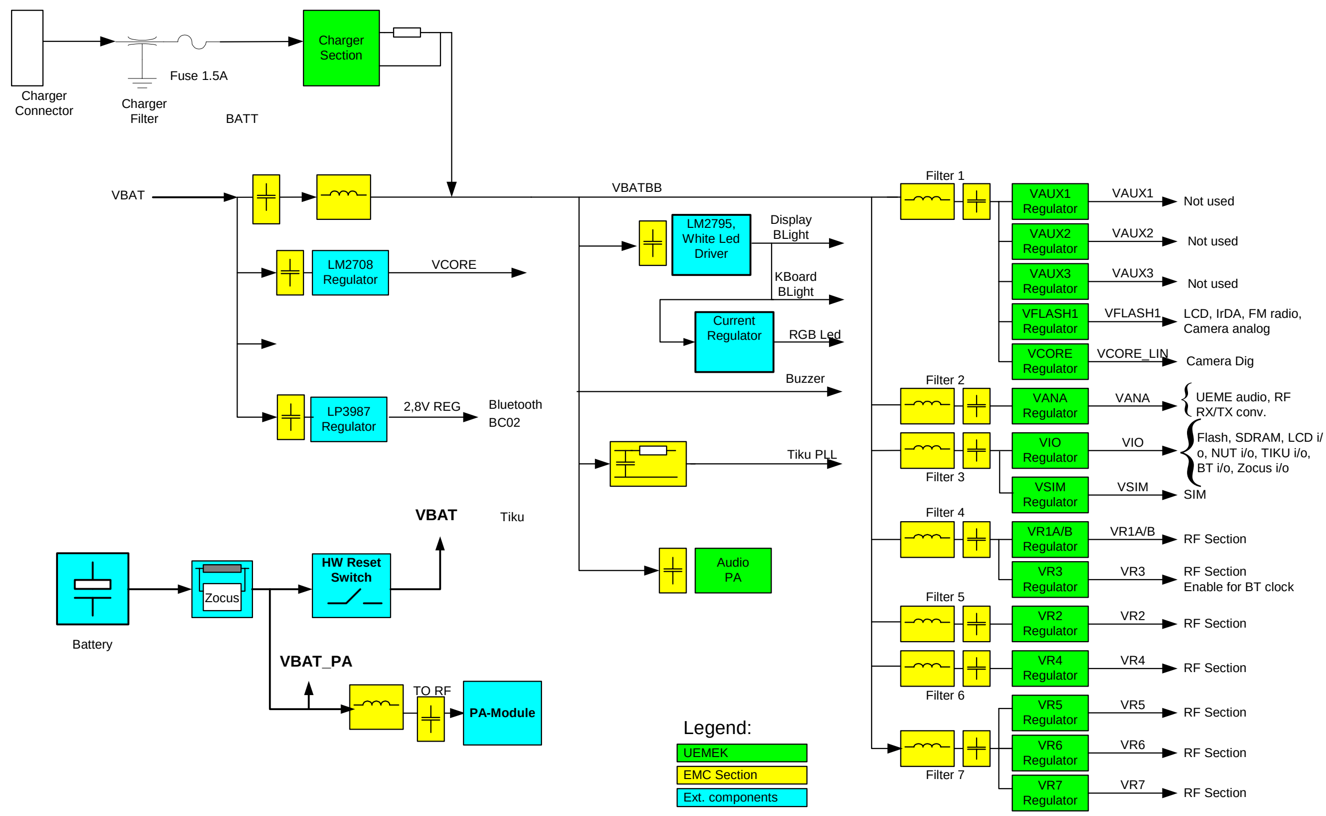
An external regulator (SMPS) provides the core voltage for the phone processor (TikuEDGE).

The inputs of the UEMEK regulators are filtered by a coil / capacitor filter. Some of the inputs are joined together..

Figure below shows the connections in the different filters.

VIO regulator is overloaded in sleep mode (this issue is inherited from Nokia 6230). Due to peak currents on display and SDRAM the maximum output current for VIO regulator (2mA) is exceeded.

Figure 4: Power Supply Overview



Internal regulator

The following list shows the internal regulators:

Table 2: Internal Regulators

Name	Voltage (V)			Current (mA)		Fil-ter	Comment
	Min	Nom	Max	Max	Sleep Max		
VANA	2.70	2.78	2.86	80		2	5uA minimum for stability. Controlled by the UEMEK. Disabled in Sleep mode.
VFLASH1	2.7 (2.61)	2.78	2.86 (2.95)	70	1.5	1	5uA minimum for stability. Controlled by the UEMEK. (Sleep indication)

Name	Voltage (V)			Current (mA)		Fil-ter	Comment
	Min	Nom	Max	Max	Sleep Max		
VIO	1.72	1.80	1.88	150	2	3	5uA minimum for stability. Controlled by the UEMEK.
VCORE Camera on	1.71	1.8	1.89	200	0.2	1	5uA minimum for stability. MCUSW is setting the voltage.
VAUX1	1.745 2.91	1.80 3.0	1.855 3.09	50	0.5	1	Voltage level is set by MCUSW.
VAUX2	2.70	2.78	2.86	70	0.5	1	5uA minimum for stability.
VAUX3	2.70	2.78	2.86	20	0.5	1	5uA minimum for stability.
VSIM	1.745 2.91	1.80 3.00	1.855 3.09	25	0.5	-	5uA minimum for stability.
VR1A/B	4.60	4.75	4.90	10	-	4	Disabled in Sleep mode. The maximum current is for 1 regulator active. If both are used, maximum 5mA each.
VR2	2.70 (2.61)	2.78 (2.78)	2.86 (2.95)	100	-	5	100uA minimum for stability. Active during (Sleepmode).
VR3	2.70	2.78	2.86	20	-	4	100uA minimum for stability. Controlled by the UEMEK.
VR4	2.70	2.78	2.86	50	0.1	6	100uA minimum for stability.
VR5	2.70	2.78	2.86	50	0.1	7	100uA minimum for stability.
VR6	2.70	2.78	2.86	50	0.1	7	100uA minimum for stability.
VR7	2.70	2.78	2.86	45	-	7	100uA minimum for stability.

External regulators

VCORE SMPS

The VCORE regulator is based on the LM2708 step-down DC-DC converter. The regulator can provide 350mA and can switch between 1.35 – 1.57V output voltage. It can switch between low power mode (Sleep) (linear mode) and full power mode (switched).

- Input voltage 2.7 – 5.5V

- Output voltage 1.35V – 1.57V

- External Sync input (PWM frequency between 500kHz and 750khz)

- Output current 517mA

- Overload and thermal protection

Bluetooth regulator

An external regulator powers the BC02 module. The used regulator is a LP3987ITL by National Semiconductor. The output voltage is 2.8V and the output current is 150mA continuously.

White Led Driver

A white led driver is implemented for display backlight and key_UI le's. RGB Led Regulator

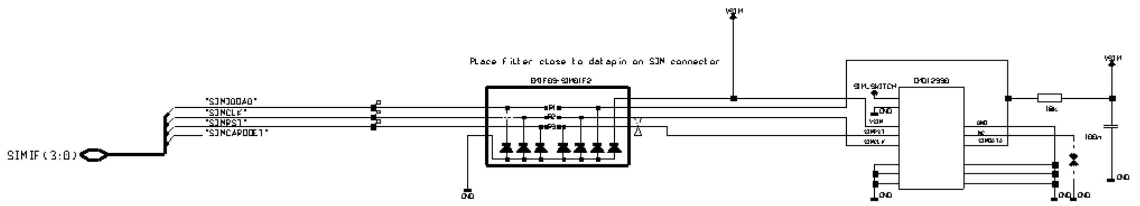
This regulator supplies the RGB led.

Filter Components

All connectors going to the "outside world" have filter components, ESD protection and EMC reduction.

The Digital/Data lines on SIM have special dedicated filter ASIP. The below figure show the SIM filtering.

Figure 5:SIM Filtering



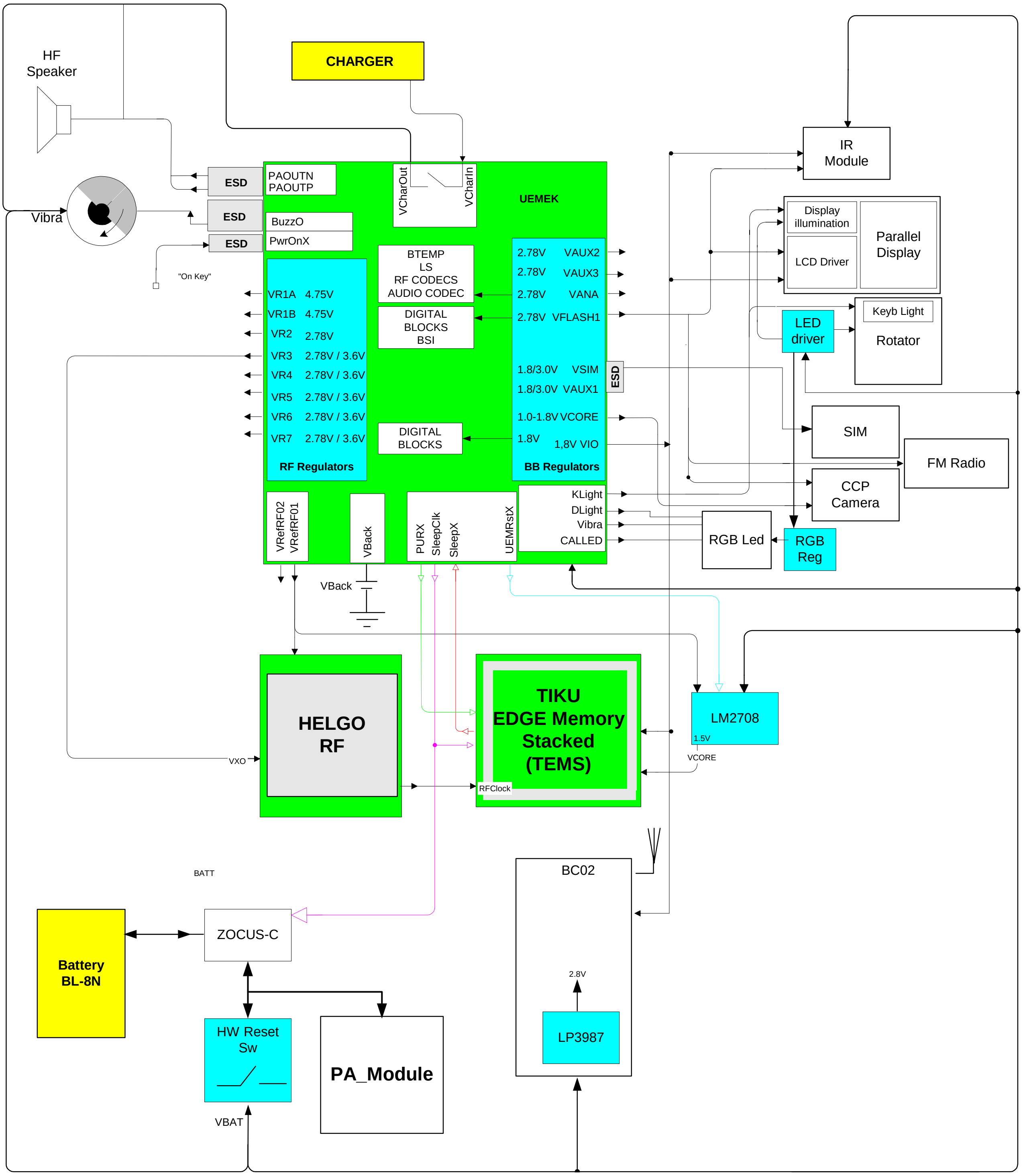
The Audio circuit: Earpiece, IHF, internal microphone and external speaker are filtered with discrete components (common mode reduction coils, Varistors, caps and resistors), where as the external microphone uses differential mode mic. ASIP.

The 16 UEMEK BB & RF regulators are specified to have a decoupling cap of 1 uF ±20%.

Power distribution

The connection of various power connection can be seen in the following overview.

Figure 6: Power Distribution

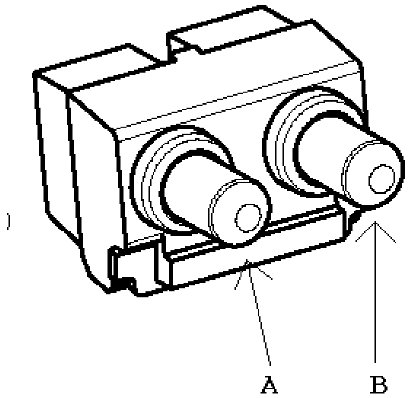


Battery connector

The battery connector has two pogo pins one for VBAT (Pin A) and one for GND (Pin B). There are no connections for either BTEMP or BSI. Hence the temperature is measured with a NTC on PWB opposite side of battery.

The connector has a dynamic movement area of 0.6 - 2.1mm with a force of 2.3 – 0.3N respectivly.

Figure 7: The connector



Battery

Type:BL-8N

Technology:Li-Ion. 4.2V charging. 3.1V cut-off

Capacity:700 mAh

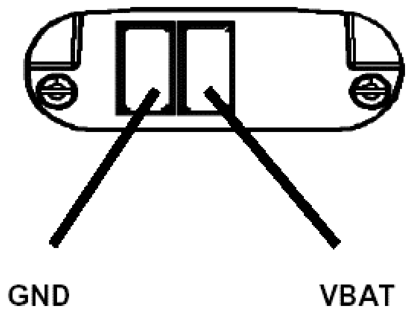
The battery pack is designed for RM-14 .

The BSI resistor is placed on the main PWB as RM-14 supports only one battery capacity. Further a BSI connection is added to the Flash interface.

The battery temperature is measured by a NTC resistor placed on the main PWB, opposite to the Battery.

Battery pack has an impedance of 130 - 150mΩ (0 – 45^{o}C).

Figure 8: BL-8N Battery



Inside the battery, an over-temperature and an over-voltage protection circuit are present. Operational temperatures of battery are –20 – 70°C in discharge mode.

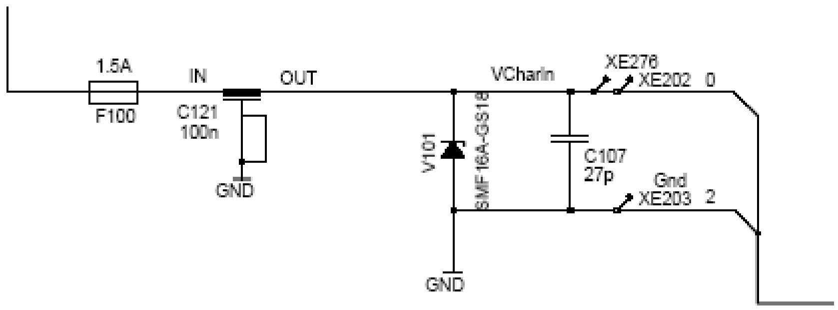
Care should be taken with the temperature. If the battery is charged above 60 degrees Celsius, overheating might occur.

Charger interface

RM-14 conforms to the global NMP Charger Interface.

Charging is controlled by the UEMEK. The charger connection is through the system connector interface. The RM-14 baseband is designed to support both 2- and 3-wire type chargers.

Figure 9: Charger Circuit



System Connector

The system connector in RM-14 is a plug and play connector.

The Plug & Play system connector supports the fully differential DCT4, 4-wire audio/control interface which includes:

Audio

- 2 -wire fully differential mono audio

- 2-wire differential mic input

Detection/controlling

- Headint passive brake switch

Not supported is:

- Pins for 2 -wire charging in cradles

Table 3: DC Plug pinlist

PinNo	Pin Name	Description	Voltage levels, Current	Comment
2	CHARGE	Charger input	0-16,9V, 0,85A	Max Voltage Peak from AC-7 used.
1	GND	Ground	0,85A	

Interfaces

Camera

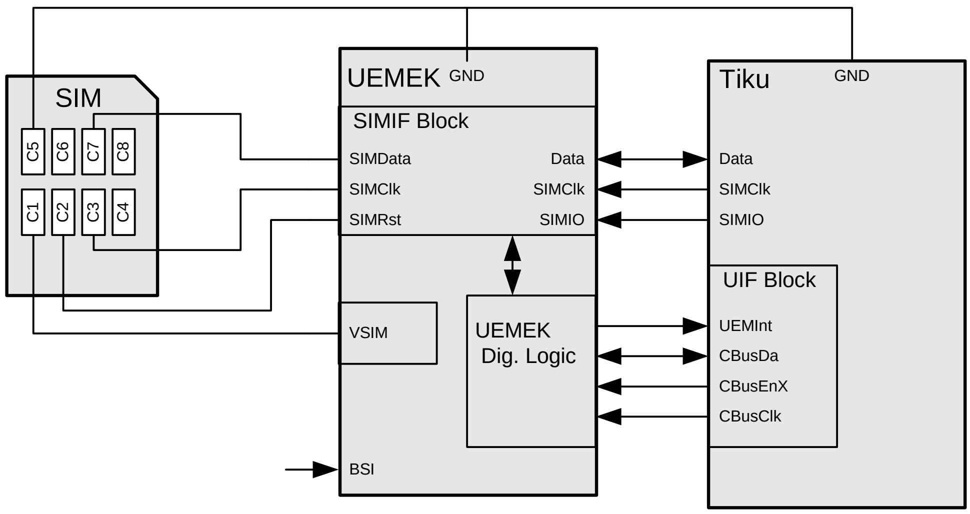
The module has only one operating mode: Bayer mode (raw pixel data output). Thus viewfinder, video streaming, colour correction, white balance etc. must be handled in software.

SIM interface

The engine first tries to contact SIM card with 1.8V. If no response is given, 3.0V supply is tried instead.

The whole SIM interface locates in two asics; TIKU and UEMEK.

Figure 10: TIKU/UEMEK SIM Interface Connections



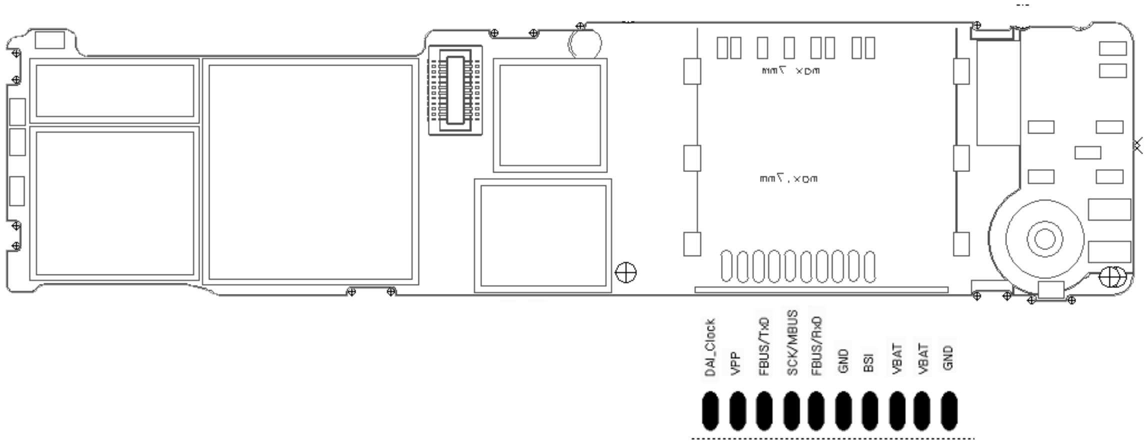
The internal clock frequency from the CTSI Block is 13 MHz in GSM.

Flash Pads Pattern

These are accessed through the SIM Can by removing the SIM draw'. There is no access to the battery connector and hereby the battery, through this interface connection. The battery cannot be charged when the POS adapter is inserted.

The power is supplied to the Engine for purposes of power supply during flashing only. Also, this interface is used for flashing when battery is inserted, and hereby the I/F ensures that there is no connection to battery.

Figure 11: FINUI and LABEL I/F



Connectivity

IrDA

RM-14 suppports data connectivity via the Infra Red link. The IR interface is integrated into the TIKU and the main external component is the IR module. The datarate supported will be 1.152Mbit. The circuit around the module is the same as in Nokia 6230. However, since the IR window due to design reasons is lifted in relations to the PWB an lightguide has to connect the IR light and the IR window. Thus the upfiring module TFDU5307 from Vishay has been selected, instead of the one used in Nokia 6230.

IrDA Tiku EDGE Interface

This interface receives data from, and transmits data to peripheral equipment. It transforms serial data to parallel data, for the MCU or DSP, and vice versa.

Audio

The audio and vibrator functions are specified UI

Display unit

Mounting

The Display Unit interface is a parallel interface.

Engine Interface

A 24-pin connector provides the interface between the Display Unit and the Engine PWB.

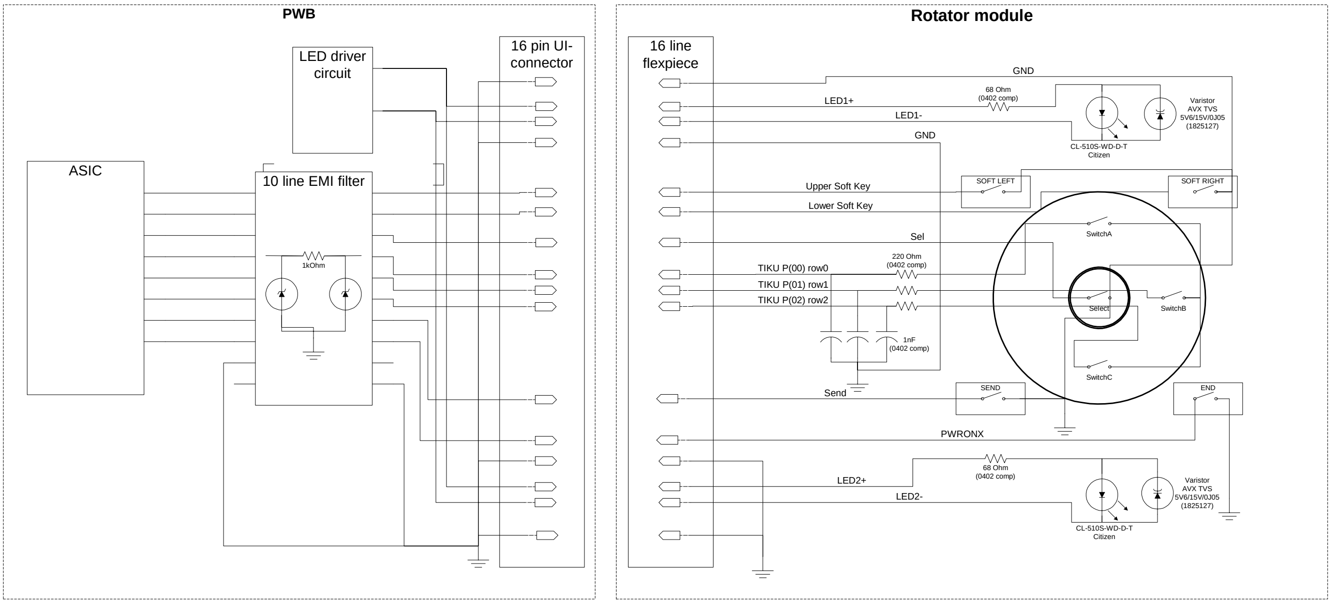
Keyboard/UI

UI module

RM-14 is instead of a traditional alphanumerical keyboard equipped with a rotator. The user interface is thus the rotator + 5 keys (upper soft key, lower soft key, send, end/power, select). All this combined with backlight is called UI module.

The schematic of the complete UI-module can be seen below.

Figure 12: Schematic for UI module



In the middle of the rotator there is a select key. On top of this 4 keys are present, these are:

- Send

- End/power-key

- Upper soft key

– Lower soft key

These are implemented so that they can be pressed (and detected) simultaneously.

The powerkey is implemented in the END key. Therefore this will be connected to the PWRONX pin on the UEME.

Rotator

The connections from the rotator module (including keys) to the engine are:

Function	Connecting IC	Pin	Level pressed/ unpressed
Upper soft key	TIKU	GPIO2 (col0)	0/Open
Lower soft key	TIKU	GPIO3 (col1)	0/Open
Select	TIKU	GPIO13	0/Open
Switch A	TIKU	GPIO10	--
Switch B	TIKU	GPIO9	--
Switch C	TIKU	GPIO8	--
Send	TIKU	GPIO4	0/Open
End/Power	UEME	PWRONX	0/Open

Function during use

This consists of 3 switches which during rotation open and close in the following pattern:

Figure 13:Function during use

Position		1		2		3		1		2
Terminal	Between detents	Detent	Between detents	Detent	Between detents	Detent	Between detents	Detent	Between detents	Detent
A	Contact metal	Contact metal	Open plastic	Open plastic	Open plastic	Contact metal	Contact metal	Contact metal	Open plastic	Open plastic
B	Open plastic	Contact metal	Contact metal	Contact metal	Open plastic	Open plastic	Open plastic	Contact metal	Contact metal	Contact metal
C	Open plastic	Open plastic	Open plastic	Contact metal	Contact metal	Contact metal	Open plastic	Open plastic	Open plastic	Contact metal

In the following:

-contacts in rotator are CAPITAL LETTERS

-pins on TIKU are corresponding lowercase letters (Thus switch A corresponds to pin A on TIKU).

If the system has been initalized following routine is present (starting at point 1):

System has enabled pin c (driven low), a and b are disabled (pulled high).

Pos. 1: Contact A and B are closed, C is open (pin a = hi, b = hi, c = lo).

Between 1 & 2: Rotating the wheel CW causes:

Contact A to open => Now only B is closed, (pin a = hi, b = hi, c = lo).

Pos. 2: Rotating further CW causes:

C to close => now B and C is closed, This causes a low interrupt on pin b (pin a = hi, b = lo, c = lo).

New state in SW is set: (pin a = lo, b = hi, c = hi). Now ready for next step.

Between 2 & 3: Rotating further CW causes:

B to open => now only C is closed, (pin a = lo, b = hi, c = hi).

Pos. 3: Rotating further CW causes:

A to close => Now A and C are closed. This causes a low interrupt on pin c (pin a = lo, b = hi, c = lo).

New state in SW is set: (pin a = hi, b = lo, c = hi). Now ready for next step.

Between 3 & 1: Rotating further CW causes:

contact C to open => Now only A is closed.

Pos.1: This is similar to the first position 1. The pattern is repeated.

This pattern will go on as long as the rotator is turned CW, and the switches open and close regulairy.

This means:

-In between steps only one switch is closed. This switch stays closed while the 2 other are changing state.

-Every time a switch closes a low interrupt is generated.

-When going CCW the same pattern will happen, but in opposite order.

-Every time an interrupt is generated a new state has to be set.

-If a false state occurs, initalization routine has to be run until a correct state is reached.

Whether the rotator movement is CW (down) or CCW (up) can thus be decoded by comparing the interrupt pin with the stage of the last interrupt.

Slide switch

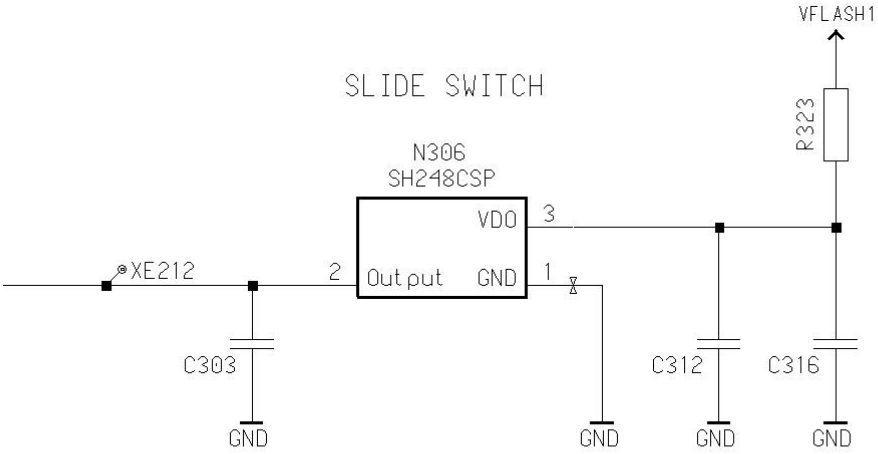
A switch is needed to detect the position of the slide.

Connection to the engine:

Connecting pin	Connecting IC	Function	Open/ Closed
AuxDet	UEME	Output from Hall IC tells if slide is open or closed	1/0

This switch is implemented with a hall IC and a magnet. The hall IC is SH248CSP from Samsung.

Figure 14: The switch



The signal from the Hall IC is connected to the analog keyboard input (AuxDet) in the UEME, as this also is an interrupt input. This allows the phone to wake up, by opening the phone.

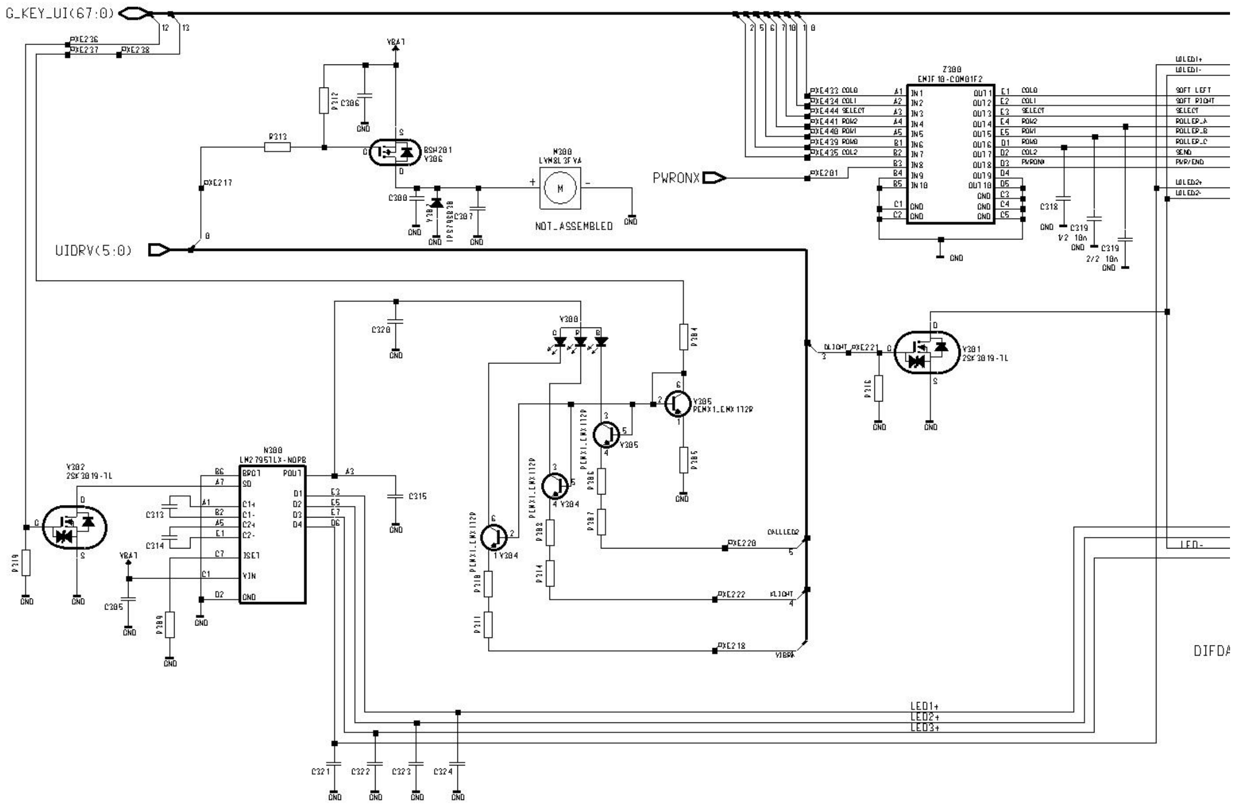
Analog keyboard input is used due to interrupt possibilities and because the Hall IC requires a minimum supply voltage of 2.7V.

The Hall solution requires a magnet, which is placed on top of Hall-IC, and is moved away from the sensor with the moving mechanics, thus making a change of the magnetic field. The magnet has the dimensions 5x3x1 mm and is mounted in the top of the phone in the sliding part.

LED driver

The general LED driver circuit looks as follows:

Figure 15: LED driver



Generel circuit description

The circuit is build around LM2795(NMP code: 4341425. This is a switched capacitor type step up converter. It has 5 outputs. 4 of them are mirrored current sources (D1-D4), and the 5th is the output from the chargepump(Pout).

Driving display and UI backlight

The mirrored current sources are used to drive the display backlight (D1-D3), and the backlight(D4) to the UI-module (rotator).

Driving RGB LED

The Pout output (from the chargepump) is fed to the RGB LED's.

RF Module Introduction

The RF module performs the necessary high frequency operations of the EGSM900/GSM1800/GSM1900 tripleband (EDGE) engine in the RM-14 product.

Both the transmitter and receiver have been implemented by using direct conversion architecture, which means that the modulator and demodulator operate at the channel frequency.

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

Other key components include:

- 26 MHz VCTCXO for frequency reference
- 3296-3980 MHz SHF VCO (super high frequency voltage controlled oscillator)
- front end module comprising a RX/TX switch and two RF bandpass SAW filters
- three additional SAW filters

The control information for the RF is coming from the baseband section of the engine through a serial bus, referred later on as RFBus. This serial bus is used to pass the information about the frequency band, mode of operation, and synthesizer channel for the RF.

In addition, exact timing information and receiver gain settings are transferred through the RFBus. Physically, the bus is located between the baseband ASIC called TIKU and Helgo.

The RF circuitry is located on both sides of the 8 layer PWB.

EMC leakage is prevented by using metal cans. The RF circuits are separated to four blocks:

– FM radio.

–PA, front end module and VCTCXO.

– Helgo RF IC, baluns and balanced filters.

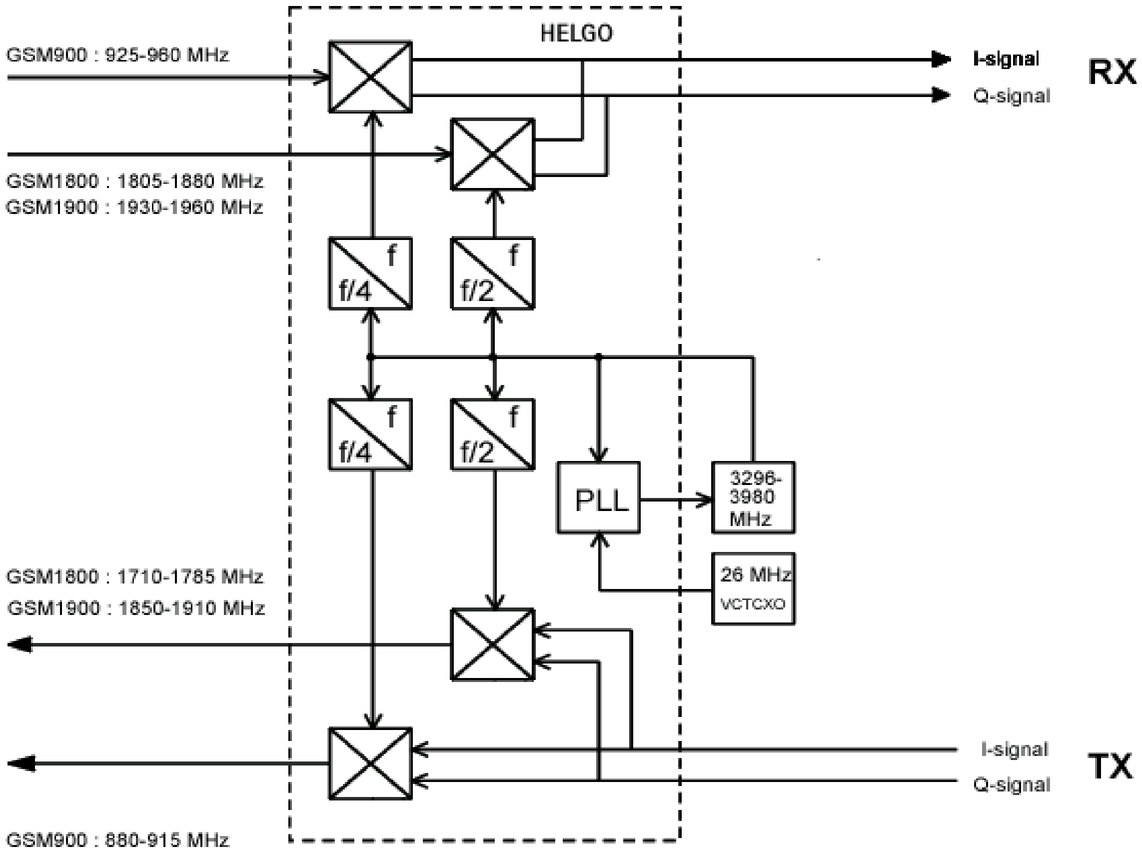
– VCO

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

RF Frequency Plan

RF frequency plan is shown below. The VCO operates at the channel frequency multiplied by two or four depending on the frequency band of operation.

Figure 16: RF Frequency Plan



Regulators

The transceiver baseband section has a multi function analog ASIC, UEM, which contains among other functions six pieces of 2.78 V linear regulators and a 4.8 V switching regulator.

The seven regulators are named VR1 to VR7. VrefRF01 and VrefRF02 are used as the reference voltages for the Helgo, VrefRF01 (1.35V) for the bias reference and VrefRF02 (1.35V) for the RX ADC (analog-to-digital converter) reference.

The regulators (except for VR7) are connected to the Helgo.

List of the needed supply voltages

Volt. Source	Load
VR1	PLL charge pump (4.8 V)
VR2	TX modulators, VPECTRL3s (ALC), driver
VR3	VCTCXO, synthesizer digital parts
VR4	Helgo pre-amps, mixers, DtoS
VR5	dividers, LO-buffers, prescaler
VR6	LNAs, Helgo baseband (Vdd_bb)
VR7	VCO
VrefRF01	ref. Voltage for Helgo
VrefRF02	ref. Voltage for Helgo
Vbatt	PA

Typical Current Consumption

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

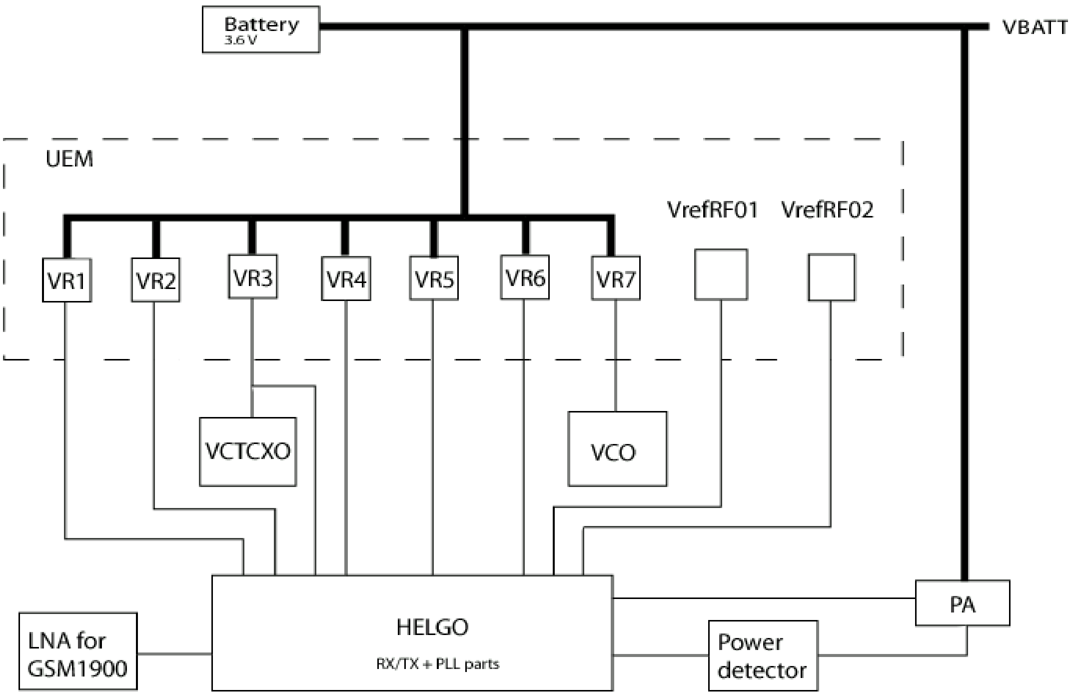
Operation mode	Current consumption	Notes
Power OFF	< 10 uA	
RX, EGSM900	75 mA, peak	
RX, GSM1800/ GSM1900	70 mA, peak	

TX, power level 5, EGSM900	1700 mA, peak	
TX, power level 0, GSM1800/GSM1900	1000 mA, peak	

Power Distribution

Power Distribution Diagram

Figure 17:Power distribution diagram



RF Characteristics

Main RF Characteristics

Parameter	Unit and value
Cellular system	EGSM900/GSM1800/GSM1900
RX Frequency range	EGSM900: 925 ... 960 MHz GSM1800: 1805...1880 MHz GSM1900: 1930...1990 MHz
TX Frequency range	EGSM900: 880 ... 915 MHz GSM1800: 1710 ...1785 MHz GSM1900: 1850 …1910 MHz
Duplex spacing	EGSM900: 45 MHz GSM1800: 95 MHz GSM1900: 80 MHz
Channel spacing	200 kHz
Number of RF channels	EGSM900: 174 GSM1800: 374 GSM1900: 300
Output Power	EGSM900: GSMK 5…33 dBm EGSM900: 8-PSK 5…27 dBm GSM1800: GSMK 0…30 dBm GSM1800: 8-PSK 0…26 dBm GSM1900: GSMK 0…30 dBm GSM1900: 8-PSK 0…26 dBm
Number of power levels GMSK	EGSM900: 15 GSM1800: 16 GSM1900: 16
Number of power levels 8-PSK	EGSM900: 12 GSM1800: 14 GSM1900: 14

Transmitter Characteristics

Item	Values (EGSM900/1800/1900)
Type	Direct conversion, nonlinear, FDMA/TDMA
LO frequency range	EGSM900: 3520...3660 MHz (4 x TX freq) GSM1800: 3420...3570 MHz (2 x TX freq) GSM1900: 3700...3820 MHz (2 x TX freq)

Output power (EGSM900/GSM1800/GSM1900)	GMSK 33/30/30 dBm 8-PSK 27/26/26 dBm

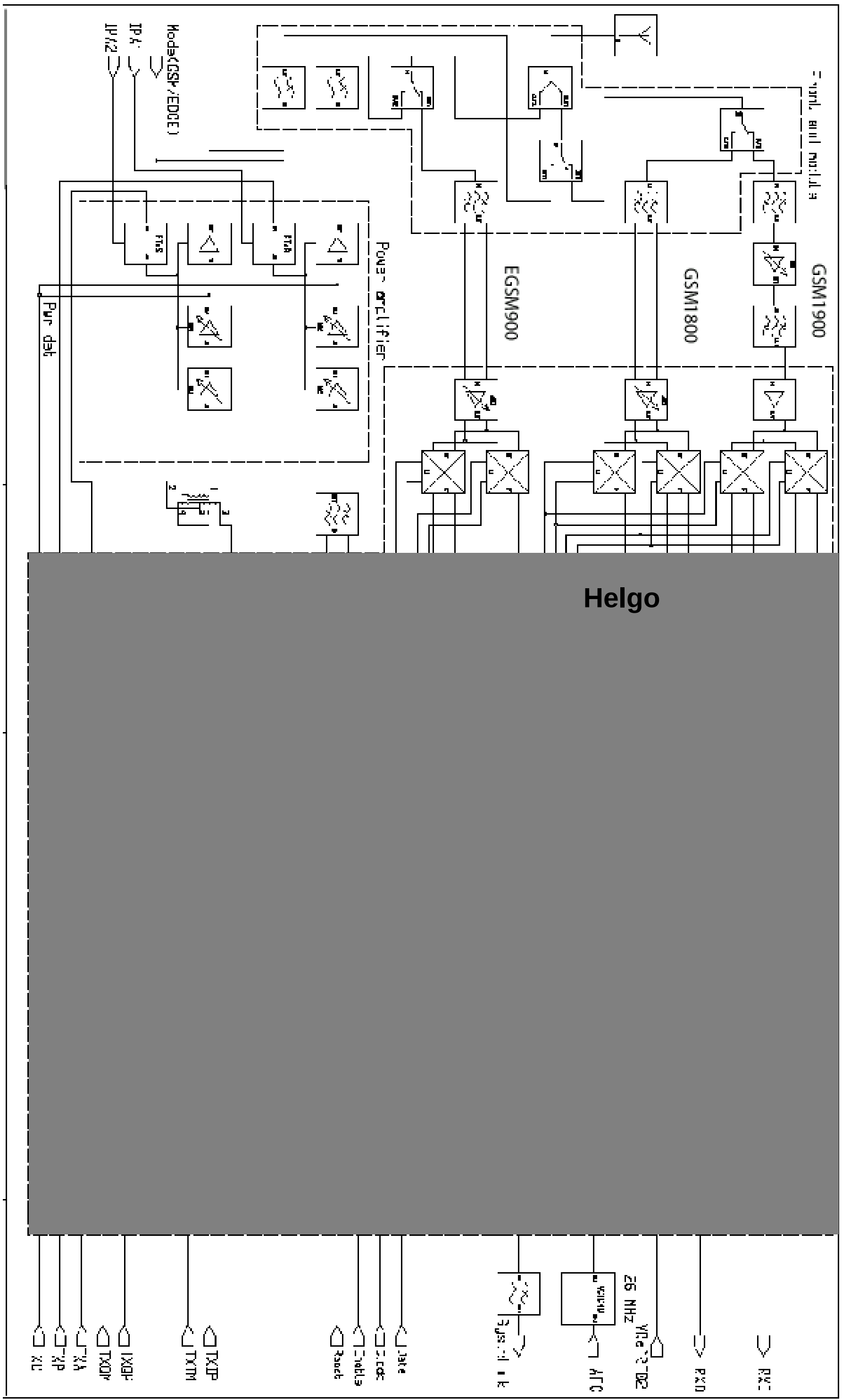
Receiver Characteristics

Item	Values, EGSM900/1800/1900
Type	Direct conversion, Linear, FDMA/TDMA
LO frequencies	EGSM900: 3700...3840 MHz (4 x RX freq) GSM1800: 3610...3760 MHz (2 x RX freq) GSM1900: 3860...3980 MHz (2 x RX freq)
Typical 3 dB bandwidth	+/- 91 kHz
Sensitivity	min. - 102 dBm (normal condition)
Receiver output level (RF level -95 dBm)	230 mVpp, single-ended I/Q signals to RX ADCs

RF Block Diagram

The block diagram of the RF module can be seen in Figure 15. The detailed functional description is given in the following sections.

Figure 18: RF Block Diagram



Frequency Synthesizers

The VCO frequency is locked by a PLL (phase locked loop) into a stable frequency source given by a VCTCXO, which is running at 26 MHz.

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

Receiver

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

Most of the receiver circuitry is included in Helgo.

Transmittter

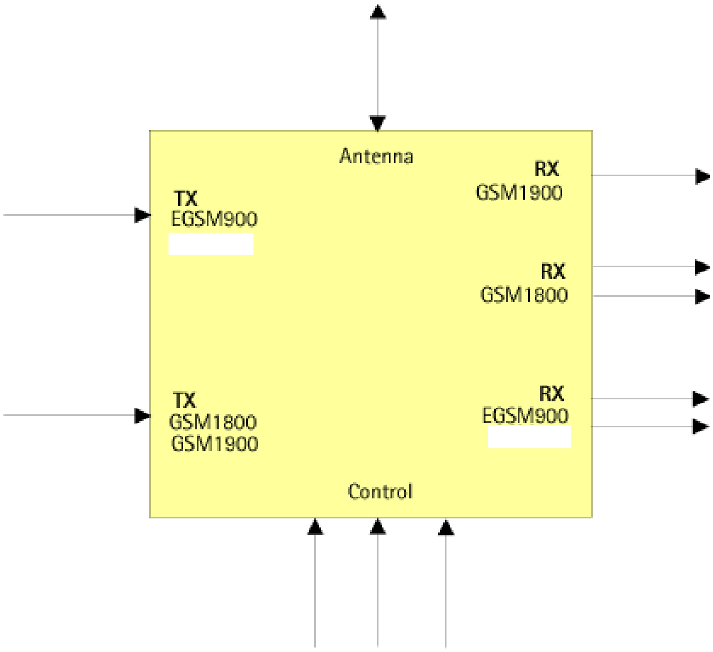
The transmitter consists of two final frequency IQ-modulators and power amplifiers, for the lower and upper bands separately, and a power control loop. The IQ-modulators are integrated in Helgo, as well as the operational amplifiers of the power control loop. The two power amplifiers are located in a single module with power detector.

Front end

The front end features include:

- Antenna 50 ohm input
- RX EGSM900 balanced output
- RX GSM1800 balanced output
- RX GSM1900 single ended output
- TX GSM900 single ended 50 ohm input
- TX GSM1800/GSM1900 single ended 50 ohm input
- 3 control lines from the Helgo

Figure 19: Front end



Power amplifier

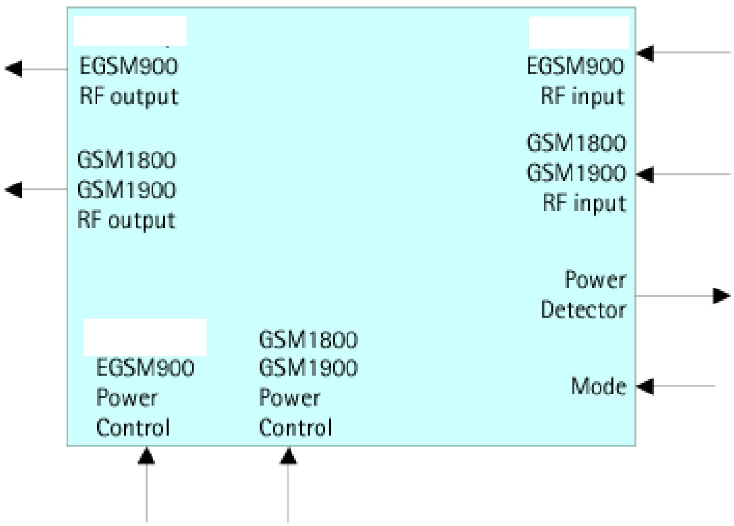
The power amplifier features include:

50 ohm input and output, EGSM900 and GSM1800/GSM1900

Internal power detector

GMSK and EDGE mode

Figure 20: Power Amplifier



RF ASIC Helgo

The RF ASIC features include

Balanced I/Q demodulator and balanced I/Q modulator

Power control operational amplifier, acts as an error amplifier

The signal from VCO is balanced, frequencies 3296 to 3980 MHz

Low noise amplifiers (LNAs) for EGSM900 and GSM1800 are integrated.

The Helgo can be tested by test points only.

AFC function

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

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