3. RF+System Module KL8

AMENDMENT RECORD SHEET

Amendment Number	Date	Inserted By	Comments
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CONTENTS –Troubleshooting

Abbreviations

ACCIF	ACCessory InterFace block of MADLinda
A/D	Analog–to–Digital
ADC	Analog–to–Digital Converter
AFC	Automatic Frequency Control
AGC	Automatic Gain Control
AMM	ARM MegaModule
API	ARM Port Interface in LMM
ARM	Advanced RISC Machines
ASIC	Application Specific Integrated Circuit
AVG	Average
BB	Baseband
BGA	Ball Grid Array package
KL8	RAE-3 System/RF module
BLL–3	Litium–Ion battery back for RAE-3
CCONT	Multifunction power management IC for DCT3 – used in KL8 system HW
CCR	Clock Configuration Register in MADLinda
CHAPS	DCT3 Charging control ASIC – used in KL8 system HW
CMT	Cellular Mobile Transceiver
COBBA	DCT3 RF–interface and Audio codec IC
COBBA_GJP	Serial control interface version of COBBA – used in KL8 system HW
CRFU3	UHF RF IC – used in KL8 RF HW
CSD	Card–specific Data, register in Memory Cards
CSP	Chip Scale Package
CTSI	Clocking, Timing, Sleep & Interrupt block of MADLinda
D/A	Digital–to–Analog
DAC	Digital–to–Analog Converter
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DNL	Differential non–linearity
DMA	Direct Memory Access
DL2	RAE-3NU* Color UI module
DSP	Digital Signal Processor
DTMF	Dual Tone Multi Frequency
DTR	Data Terminal Ready
EAD	External Accessory Detect
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
FBUS	Full Duplex Serial Bus in NOKIA’s phones
FFS	Flash File System
GPIO	General Purpose Input/Output (block in MADLinda)
HAGAR	Direct conversion RF ASIC – used in KL8 RF HW
HF	Hands Free
HSCSD	High Speed Circuits Switched Data

HW	Hardware
IC	Integrated Circuit
ICE	In–Circuit Emulator
INL	Integral non–linearity
IO	Input/Output
IR	Infrared
IrDA	Infrared Data Association
JTAG	Joint Test Action Group, commonly used as a synonym for boundary scan (IEEE 1149.1) testing
KL8	RAE–3N* System/RF Module
LCD	Liquid Crystal Display
LEAD	Low power Enhanced Architecture DSP
LEAD2	Digital Signal Processor block of MADLinda
LMM	LEAD2 MegaModule – DSP module in MADLinda
MAD	MCU+ASIC+DSP chip (**M**CU–**A**SIC–**D**SP)
MAD2	GSM version of MAD
MAD2PR1	A pin reduction version of the MAD2
MAD2WD1	High Speed Data version of MAD2 by Wireless Data
MADLinda	MAD based version of RAE-3 Communicator ASIC
MBUS	1–wire half duplex serial bus in NOKIA's phones
MCU	Micro Controller Unit
MFI	Modulator and filter interface in MAD2
MMC	Memory Card
MMU	Memory Management Unit
MPU	Micro Processor Unit – in text refers to MADLinda's ARM9 processor
NTC	Negative Temperature Coefficient (resistor)
PCI	Phone Control Interface
PCM	Pulse Code Modulation
PCR	Pin Configuration Register in MADLinda
PDA	Personal Digital Assistant
PHF	Personal Hands Free
PLL	Phase Locked Loop
PMM	Permanent Memory Management block (Plato UI)
PPM	Post Programmable Memory
PUP	PIO, USART and PWM block of MADLinda
PWB	Printed Wiring Board
PWM	Pulse Width Modulation
R&D	Research and development
RAM	Random Access Memory
RF	Radio Frequency
RFI	RF Interface
ROM	Read Only Memory
RTC	Real Time Clock
SCU	Synthesizer Control Unit
SCR	System Configuration Register in MADLinda
SDRAM	Synchronous Dynamic RAM
SIM	Subscriber Identify Module
SIMIF	Subscriber Identify Module Interface
SIR	Serial Infrared (speed 115.2kbit/s)

SPI	Serial Peripheral Interface
Spock	Second generation communicator RAE–2
SSR	System Status Register in MADLinda
SW	Software
TAP	Test Access Port (Boundary Scan)
TI	Texas Instruments
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver Transmitter
USART	Universal Synchronous/Asynchronous Receiver Transmitter
UI	User Interface
UI1	LED backlight UI module
VCTCXO	Voltage Controlled Temperature Compensated Oscillator
VCXO	Voltage Controlled Oscillator
VIA	Versatile Interconnection Architecture (inside MADLinda)
WD1	Wireless Data Engine 1
XIP	Execute In Place (memory)
(TBC)	(To be checked)
(TBD)	(To be defined)

RAE-3 Structure

This document specifies the system HW part of RAE-3NU* GSM900/GSM1800 Dual Band Communicator. The KL8 module contains both the system hardware and the RF components. The system part of the KL8 module functions as a combined CMT baseband and PDA engine.

RAE-3NU Modules

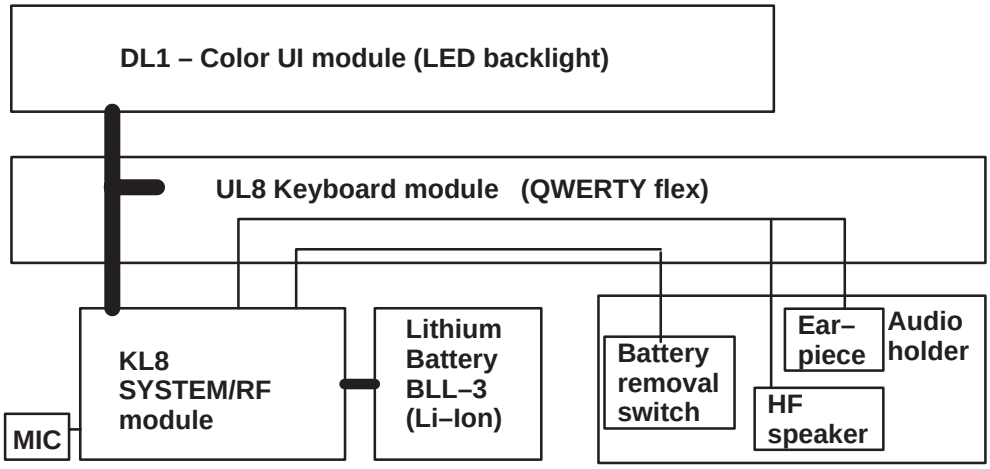

Figure 1. RAE–3NU* modules

List of Modules

Table 1. List of submodules

Name of module	Type code	Material code	Notes
RF&System	KL8	n.a.	GSM phone + PDA module
User Interface	DL1	n.a.	PDA + CMT displays, Colour LCD
UI PWB	UL1	0201899	PWB without displays,
PDA display		4850255	Colour LCD display 640x200
Keyboard and Hinge flex	UL8	0201667	Audio PWB and connectors

Technical Summary of System Part

The RAE-3 system hardware is based on a special version of the MAD2 ASIC called MADLinda. MADLinda carries out all the signal processing and operation controlling tasks of the phone as well as all PDA tasks. To be able to run simultaneously both CMT and PDA applications, MADLinda (ROM1) has a 52MHz ARM9 core.

MADLinda's main blocks include: ARM925 MPU Subsystem, Traffic Controller (TC), LEAD2 DSP megamodule (LMM), GSM System Logic and PDA peripherals. ARM925 MPU Subsystem includes ARM9TDMI core, data and instruction caches, data and instruction memory management units (MMU) and write and address buffers. Traffic Controller includes primary DMA controller, LCD controller and Flash and SDRAM memory interfaces. The System Logic of MAD2 is able to support high speed data features (HSCSD). PDA peripherals include interfaces for Serial Flash, MMC, IrDA, serial port, IOs and PWMs.

In addition of the MADLinda IC the system hardware includes memories, infrared transceiver, COBBA_GJP, CCONT and CHAPS ASICs, audio amplifier and power regulators. CSP packages are used for all ASICs. System HW also has connectors for Memory Card (MMC) and SIM card, UI connector and pads for system connector's spring contacts.

Two 8Mb XIP Flash devices are used for program code storage.

A 16Mbyte DiscOnChip (DOC) Flash memory is used with the flash file system, having user data and part of the applications.

Applications in DOC memory are loaded to SDRAM for program execution.

The main battery voltage range in RAE-3 is 3.0V to 4.2V. Battery charging is controlled in SW using CCONT and CHAPS ASICs. RAE-3 can also supply 3 V(max 100mA) accessory voltage out from system connector.

The system electronics run from a 2.8V power rail. 1.8V is used as core voltage inside MADLinda and as I/O voltage for XIP Flash memory interface.

Power supplying of the KL8 module, both system HW and RF, and also 2.8V supplying for the UI module is carried out in system HW. A linear regulator is used to generate 2.8V VBB voltage and a DC/DC converter is used to generate the 1.8V Vcore voltage. Accessory voltage and MMC supply are generated with separate 3V linear regulators. Other supplies are generated using the CCONT power ASIC (4.7V needed in DCT4 RF is generated in RF side). CCONT generates also the main reset for the system.

Both 3V and 5V Plug–in SIM–cards are supported. SIM is interfaced through CCONT, which does signal level shifting and generates correct supply voltage for SIM.

A real time clock function is integrated into CCONT, which utilizes the same 32kHz clock supply as the sleep clock. A rechargeable backup battery provides backup power to run the RTC when the main battery is removed. The backup time is about 10 days. Note also the information in section 8 chapter 2.6.

The interface from the system part and the RF and audio sections is handled by a specific ASIC COBBA_GJP. 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 COBBA_GJP and the MADLinda is implemented using serial connections. Digital speech processing is executed by the MADLinda ASIC.

External audio is connected to RAE-3 through system connector's XMIC and XEAR lines.

Serial connection channels in RAE-3 include IrDA, MBUS, and serial port. MBUS and serial port have logic level signals which are connected through system connector. IR transceiver is next to the system connector at the bottom end of RAE-3 device.

Block Diagram

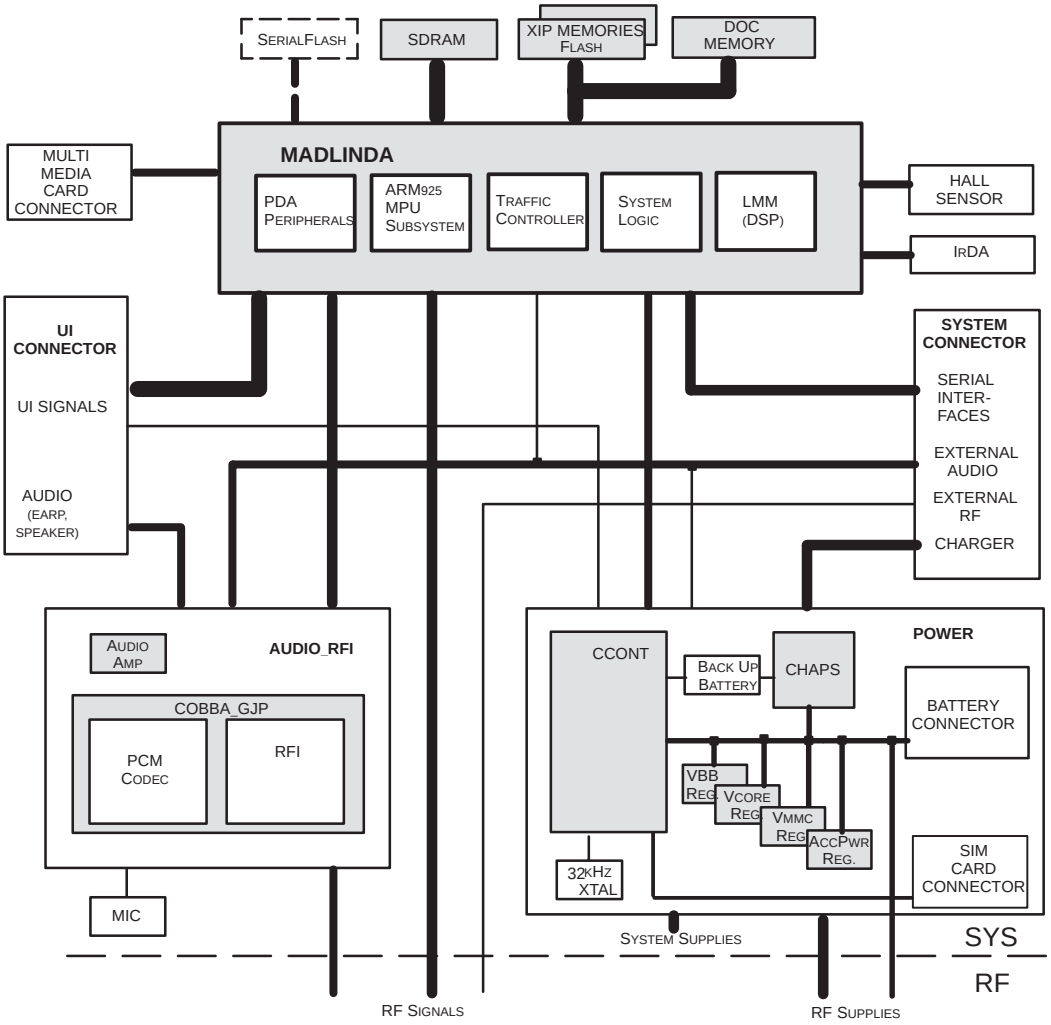

Figure 2. HW system part block diagram

Electrical Characteristics

Power Supply

Table 2. **Operating voltages and power consumptions**

Name	Parameter	Min	Typ	Max	Unit	Notes
VIN	Voltage	3.4		18	V	Charging voltage
VBATT	Voltage	3.0	3.6	4.8	V	Voltage directly from main battery –to Vcore req. and RF part,
			450		mA	typical for whole KL8
VB	Voltage	3.0	3.6	4.8	V	Filtered battery voltage – to VBB req. and to UI
VB_CCONT	Voltage	3.0	3.6	4.8	V	Filtered battery voltage – to CCONT and audio HF amplifier
VBB	Voltage	2.74	2.8	2.86	V	System HW supply voltage,
	Current		45	400	mA	typ. measured, max available from regulator
FLVPP	Voltage	0	2.8		V	Connected to MADLinda IO in assembled de-vise. Functions as program enable in 2.8V.
	Current		36		uA	Takes flashing current form Vcc pin
Vcore	Voltage	1.7	1.8	1.9	V	Core voltage – to MADLinda and XIP Flash IF
	Current		70	300	mA	typ. measured, max available form regulator
VMMC	Voltage	2.74	3.0	3.1	V	MMC supply voltage
	Current			100	mA	max supported consumption level
VACC	Voltage	3.03	3.3	3.4	V	Accessory supply voltage output
	Current			100	mA	max current out
VSIM	Voltage	4.8	5.0	5.2	V	Voltage to SIM, 5V selected (CCONT VSIM)
	Current	3	10	30	mA	2)
	Voltage	2.8	3.0	3.2	V	Voltage to SIM, 3V selected
	Current	1	6	30	mA	2)
VCOBBA	Voltage	2.7	2.8	2.85	V	COBBA_GJP analog supply (CCONT VR6)
	Current		15.7		mA	current during call, 4)
VXO	Voltage	2.7	2.8	2.85	V	To RF (CCONT VR1)
	Current			63	mA	Available from CCONT, 4)
VRX	Voltage	2.7	2.8	2.85	V	To RF (CCONT VR2)
	Current			63	mA	Available from CCONT, 4)
VSYN_1	Voltage	2.7	2.8	2.85	V	To RF (CCONT VR4)
	Current			63	mA	Available from CCONT, 4)
VSYN_2	Voltage	2.7	2.8	2.85	V	To RF (CCONT VR3)
	Current			50	mA	Available from CCONT, 4)
VTX	Voltage	2.7	2.8	2.85	V	To RF (CCONT VR5)
	Current			63	mA	Available from CCONT, 4)
VCP	Voltage	4.8	5.0	5.2	V	To RF (CCONT V5V)
	Current			30	mA	Available from CCONT, 2)

Table 2. Operating voltages and power consumptions (continued)

Name	Parameter	Min	Typ	Max	Unit	Notes
VREF	Voltage	1.478	1.500	1.523	V	Reference voltage to COBBA_GJP and RF (VREF_2) (CCONT VREF)
	Current			150	µA	Available from CCONT,
	Current			36	µA	Consumption in system HW

2) VCP and VSIM together max 30mA
4) Total current from CCONT VR1–VR6 max 330mA rms

System Connector

Table 3. Electrical characteristics of the system connector (X450) signals

Pin	Name	Parameter	Min	Typ	Max	Unit	Notes
1	L_GND		0	0	0	V	Supply ground
2	VIN	Voltage in			30	V	CHAPS' absolute max. input voltage
		Current in			1.5	A	Fusing current
		Voltage in	6.8	7.8	8.8	V	Unloaded Fast Charger (ACP–9, LCH–9)
		Current in			850	mA	Charging current
		Voltage in	8.5	10.0	14.0	V	Unloaded Standard Charger (ACP–7)
		Current in		350		mA	Charging current
3	CHRG_ CTRL	Output LOW	0		0.5	V	Charger control (PWM) low
		Output HIGH	2.4		2.85	V	Charger control (PWM) high
		PWM Frequency		32		Hz	fast charger connected
		PWM duty cycle	1		99	%	
		Output resistance		22		kΩ	
4	SGND	Output AC impedance		47		Ω	ref. to GND
		Series output capacitance		10		µF	
		Resistance to phone ground		330		Ω	
5	XEAR	Output AC impedance		47		Ω	ref. to GND
		Series output capacitance		10		µF	
		Load AC impedance	16		300	Ω	ref. to SGND (Headset)
		Load AC impedance	4.7	10		kΩ	ref. to SGND (Accessory)
		Max. output level			1.8	Vpp	no load
		Load DC resistance		10		kΩ	ref. to SGND (Accessory)
		Load DC resistance	16		1500	Ω	ref. to SGND (Headset)
		DC voltage		2.8		V	44k pull–up to VBB
		Earphone signal	0	70	630	mVrms	HF–HFCM from COBBA_GJP HF output

Table 3. Electrical characteristics of the system connector (X450) signals (continued)

Pin	Name	Parameter	Min	Typ	Max	Unit	Notes
6	XMIC	Input AC impedance		2.2		kΩ	
		Max. input signal			1	Vpp	
		Output DC level	1.47		1.55	V	Accessory muted (not for headset)
		Output DC level	2.5		2.8	V	Accessory unmuted
		Bias current	100		600	µA	
7	MBUS	Output LOW	0		0.22*VBB	V	Open drain output
		Output LOW current			2	mA	
		Pullup resistance		4.7		kΩ	to VBB
		Series resistance		270		Ω	
		Input LOW	0		0.3*VBB	V	
		Input HIGH	0.7*VBB		VBB	V	
8	DCE_TX	Input LOW	0		0.3*VBB	V	To AccRxData
		Input HIGH	0.7*VBB		VBB	V	220kΩ Pullup to VBB in KL8
		Series resistance		270		Ω	
9	DCE_RX	Output LOW	0		0.22*VBB	V	From AccTxData
		Output HIGH	0.8*VBB		VBB	V	47kΩ Pullup to VBB in KL8
		Output current			4	mA	
		Series resistance		270		Ω	
10	DCE_DTR	Input LOW	0		0.3*VBB	V	Data Terminal Ready input
		Input HIGH	0.7*VBB		VBB	V	Internal pullup max. 140µA
		Series resistance		270		Ω	
							Accessory power output
11	GND		0		0	V	Supply ground
12	RF_GND						
13	RF_INTER-NAL						To internal antenna
14	RF_COM-MON						From RF
15	RF_GND						

Battery Connector

Table 4. Battery Connector (X100) Electrical Specifications

Pin	Name	Min	Typ	Max	Unit	Notes
1	VBATT	3.0	3.6	4.2	V	Battery voltage
				4.8	V	Maximum voltage with charger
2	BSI	0		2.8	V	Battery size indication System HW has 100kΩ 5% pull up resistor. Battery removal detection (shorter contact) (Threshold is 2.4V@VBB=2.8V)
			22±1%		kΩ	Service battery pull down value
			68±5%		kΩ	4.2V Li–Ion battery pull down value

Table 4. Battery Connector (X100) Electrical Specifications (continued)

Pin	Name	Min	Typ	Max	Unit	Notes
3	BTEMP	0		1.4	V	Battery temperature indication Phone has 100k 5% pull–up resistor, Battery package has NTC pull down resistor: @+25C 47k 5%, B=4050±3%
		0	1		kΩ	Fast power up (in production)
4	BGND	0		0	V	Battery ground – connected directly to system HW GND

Backup battery connector

Table 5. Backup battery connector X102

Pin	Name	Min	Typ	Max	Unit	Notes
1	VBACK IN	2.82	3.15	3.28	V	Backup battery voltage from CHAPS @ Ibackup = 100μA
2	VBACK OUT	1.8		3.3	V	Backup battery voltage to CCONT/VBACK (not specified in CCONT spec)

VBACKIN and VBACKOUT are connected together in back up battery's positive terminal.

Table 6. Microphone contacts

Pin	Name	Min	Typ	Max	Unit	Notes
1	MICP			0.1	Vpp	Pad P200
2	MICN			0.1	Vpp	Pad P201
				0.2	Vpp	MICP–MICN differential voltage range
		2.0	2.1		V	MICP, MICN biasing output level

SIM card connector

Only Plug–in SIM (small SIM) cards are supported.

Table 7. SIM Connector (X101) Electrical Specifications

Pin	Signal Name Type	SIM Contact	Parameter	Min	Typ	Max	Unit	Notes
4	GND	GND	GND	0		0	V	Ground
3	VSIM	VCC (C1)	Supply Voltage	4.8	5.0	5.2	V	5V SIM Card
			Supply Voltage	2.8	3.0	3.2	V	3V SIM Card
6	SIM–DATA	I/O (C7)	Vout HIGH	4.0		VSIM	V	5V SIM Card
			Vout HIGH	2.8		VSIM	V	3V SIM Card
			Vout LOW	0		0.4	V	3V/5V SIM Card
			Trise/Tfall			1	μS	3V/5V SIM Card
	I/O		Series Resistance		100		Ω	(Vin not defined in CCONT specification)
2	SIMRST	RST (C2)	Vout HIGH	4.0		VSIM	V	5V SIM Card
			Vout HIGH	2.8		VSIM	V	3V SIM Card
			Vout LOW			0.4	V	3V/5V SIM Card
			Trise/Tfall			100	ns	3V/5V SIM Card
	O		Series Resistance		100		Ω	

Table 7. SIM Connector (X101) Electrical Specifications (continued)

Pin	Signal Name Type	SIM Contact	Parameter	Min	Typ	Max	Unit	Notes
1	SIMCLK	CLK (C3)	Vout HIGH	4.0		VSIM	V	5V SIM Card
			Vout HIGH	2.8		VSIM	V	3V SIM Card
			Vout LOW			0.4	V	3V/5V SIM Card
			Frequency		3.25		MHz	3V/5V SIM Card
			Trise/Tfall			25	ns	3V/5V SIM Card
	O		Series Resistance		47		Ω	
5	VSIM	VPP (C6)	Supply Voltage	4.8	5.0	5.2	V	Programming voltage,
			Supply Voltage	2.8	3.0	3.2	V	pin5 and pin3 tied together

MMC Connector

Table 8. MMC Connector Electrical Specifications

Pin	Signal Name Type	MMC Contact	Parameter	Min	Typ	Max	Unit	Notes
7	MMCDa	7 / DAT[0]	Output HIGH	2.1		2.9	V	Data
			Output LOW			0.65	V	
			Input HIGH	2.1		3.1	V	There is 100kΩ Pullup to
			Input LOW			0.8	V	VMMC in KL8
	I/O		Series Resistance		100		Ω	
6	GND	6 / VSS2		0		0	V	Ground
5	MMCClk	5 / CLK	Output HIGH	2.1		2.9	V	Clock
			Output LOW			0.65	V	
			Frequency	0		13	MHz	
	O		Series Resistance		100		Ω	
4	VMMC	4 / VDD	powered on	2.76	3.0	3.1	V	Supply voltage
			powered off			0		
			Current			100	mA	Supply Current
3	GND	3 / VSS1		0		0	V	Ground
2	MMCCmd	2 / CMD	Output HIGH	2.1		2.9	V	Command/Response
			Output LOW			0.65	V	
			Input HIGH	2.1		2.9	V	There is 10kΩ Pullup to
	I/O		Input LOW			0.8	V	VMMC in KL8
			Series Resistance		100		Ω	

Note: There is no pin 1 in connector
(Not connected in MMC mode; SPI mode not supported

Infrared interface

– IrDA and HP–SIR compatible
– Data rates from 9600bits/s to 115kbits/s
– Transmitter wavelength: min 880nm, max 900nm

UI Signals

Table 9. UI Connector

Pin	Signal Name Type	From/To	Parameter	Minimum	Nominal	Maximum	Unit	Function
27, 28, 29	VB	Main battery		3.0		4.8	V	Battery voltage
15	FLVPP not UI signal	Flash Vpp						pins 15 and 16 connected in UL8
16	VPROG not UI signal	MADLinda (Prog_IO)						pins 15 and 16 connected in UL8
17	VBB			2.7	2.85	2.9	V	Supply voltage
1, 8, 21, 25, 30, 34, 41, 66, 70	GND			0		0		Supply ground
49	COL0 I/O	MADLinda (Prog_IO)	Output high ”1”	0.8*VBB			V	Keyboard column
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Input high ”1”	0.7*VBB			V	
			Input low ”0”			0.3*VBB	V	
			Series resistance		200		Ω	
62	COL1 I/O	MADLinda (Prog_IO)	(Refer to COL0)					Keyboard column
60	COL2 I/O	MADLinda (Prog_IO)	(Refer to COL0)					Keyboard column
35, 59	COL3 I/O	MADLinda (Prog_IO)	(Refer to COL0)					Keyboard column
33, 54	COL4 I/O	MADLinda (Prog_IO)	(Refer to COL0)					Keyboard column
55	COL5 I/O	MADLinda (Prog_IO)	(Refer to COL0)					Keyboard column
56	COL6 I/O	MADLinda (Prog_IO)	(Refer to COL0)					Keyboard column
61	COL7 I/O	MADLinda (Prog_IO)	(Refer to COL0)					Keyboard column
53	COL8 I/O	MADLinda (Prog_IO)	(Refer to COL0)					Keyboard column
51	COL9 I/O	MADLinda (Prog_IO)	(Refer to COL0)					Keyboard column
50	ROW0 I/O	MADLinda (Prog_IO)	Output high ”1”	0.8*VBB			V	Keyboard row
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Input high ”1”	0.7*VBB			V	
			Input low ”0”			0.3*VBB	V	

Table 9. UI Connector (continued)

Pin	Signal Name Type	From/To	Parameter	Minimum	Nominal	Maximum	Unit	Function
			Series resistance		200		Ω	
69	ROW1 I/O	MADLinda (Prog_IO)	(Refer to ROW0)					Keyboard row
67	ROW2 I/O	MADLinda (Prog_IO)	(Refer to ROW0)					Keyboard row
65	ROW3 I/O	MADLinda (Prog_IO)	(Refer to ROW0)					Keyboard row
64	ROW4 I/O	MADLinda (Prog_IO)	(Refer to ROW0)					Keyboard row
32, 63	ROW5LCDCD I/O	MADLinda (Prog_IO / UIF)	Output high ”1”	0.8*VBB			V	Serial LCD driver Command/Data select
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Input high ”1”	0.7*VBB			V	Keyboard row
			Input low ”0”			0.3*VBB	V	
			Series resistance		200		Ω	
57	ROW6 I/O	MADLinda (Prog_IO)	(Refer to ROW0)					Keyboard row
68	ROW7 I/O	MADLinda (Prog_IO)	(Refer to ROW0)					Keyboard row
58	ROW8 I/O	MADLinda (Prog_IO)	(Refer to ROW0)					Keyboard row
52	ROW9 I/O	MADLinda (Prog_IO)	(Refer to ROW0)					Keyboard row
42	BATT_REM I	MADLinda (GPIO)	Input high ”1”	0.7*VBB			V	Battery removal switch
			Input low ”0”			0.3*VBB	V	
			Series resistance		200		Ω	
11	GenSClk O	MADLinda (UIF), (and to CCONT)	Output high ”1”	0.8*VBB			V	Serial LCD driver clock (Phone LCD)
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Frequency	0	3.25		MHz	3.25MHz during Phone LCD access, 2.17MHz during CCONT access
			Series resistance		200		Ω	
9	GenSDIO O	MADLinda (UIF)	Output high ”1”	0.8*VBB			V	Serial LCD driver data (Phone LCD)
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Series resistance		200		Ω	
12	LCDEN O	MADLinda (UIF)	Output high ”1”	0.8*VBB			V	Serial LCD driver chip select (Phone LCD)
			Output low ”0”			0.22*VBB	V	

Table 9. UI Connector (continued)

Pin	Signal Name Type	From/To	Parameter	Minimum	Nominal	Maximum	Unit	Function
			Output current			2	mA	
			Series resistance		200		Ω	
10	LCDPWM O	MADLinda (PWM)	Output high ”1”	0.8*VBB			V	PWM for PDA LCD contrast control
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Series resistance		200		Ω	
			Frequency	0	50.7		kHz	
31	BACKPWM O	MADLinda (PWM)	Output high ”1”	0.8*VBB			V	PWM for PDA LCD backlight control
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Series resistance		200		Ω	
			Frequency	0	231		Hz	
6	LCD_PWR O	MADLinda (GPIO)	Output high ”1”	0.8*VBB			V	PDA LCD power control
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Series resistance		200		Ω	
14	LCDRSTX O	MADLinda (GPIO)	Output high ”1”	0.8*VBB			V	Phone LCD reset
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Series resistance		200		Ω	
13	KBLIGHTS O	MADLinda (GPIO)	Output high ”1”	0.8*VBB			V	Phone LCD & keyboard light control
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Series resistance		200		Ω	
5	LCDDa0 O	MADLinda (LCD)	Output high ”1”	0.8*VBB			V	PDA LCD data
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Series resistance		200		Ω	
26	LCDDa1 O	MADLinda (LCD)	(refer to LCDDa0)				V	PDA LCD data
24	LCDDa2 O	MADLinda (LCD)	(refer to LCDDa0)				V	PDA LCD data
38	LCDDa3 O	MADLinda (LCD)	(refer to LCDDa0)				V	PDA LCD data
20	LCDDa4 O	MADLinda (LCD/GPIO)	(refer to LCDDa0)				V	PDA LCD data

Table 9. UI Connector (continued)

Pin	Signal Name Type	From/To	Parameter	Minimum	Nominal	Maximum	Unit	Function
36	LCDDa5 O	MADLinda (LCD/GPIO)	(refer to LCDDa0)				V	PDA LCD data
37	LCDDa6 O	MADLinda (LCD/GPIO)	(refer to LCDDa0)				V	PDA LCD data
22	LCDDa7 O	MADLinda (LCD/GPIO)	(refer to LCDDa0)				V	PDA LCD data
19	LCDDa8 O	MADLinda (LCD/GPIO)	(refer to LCDDa0)				V	PDA LCD data
23	LCDDa9 O	MADLinda (LCD/GPIO)	(refer to LCDDa0)				V	PDA LCD data
39	LCDDa10 O	MADLinda (LCD)	(refer to LCDDa0)				V	PDA LCD data
7	LCDDa11 O	MADLinda (LCD)	(refer to LCDDa0)				V	PDA LCD data
2	DISPClk O	MADLinda (LCD)	Output high ”1”	0.8*VBB			V	PDA LCD data clock
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Frequency		8.67		MHz	
			Series resistance		200		Ω	
40	LLClk O	MADLinda (LCD)	Output high ”1”	0.8*VBB			V	PDA LCD line data latch to display
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Frequency		10.8		kHz	
			Series resistance		200		Ω	
4	FSP O	MADLinda (LCD)	Output high ”1”	0.8*VBB			V	PDA LCD frame start sync pulse
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Frequency		51.6		Hz	
			Series resistance		200		Ω	
3	DISPON O	MADLinda (GPIO)	Output high ”1”	0.8*VBB			V	PDA LCD display logic on/off control, (MPUGenOut7 internally in MADLinda)
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Series resistance		200		Ω	
18	LCDM O	MADLinda (LCD)	Output high ”1”	0.8*VBB			V	PDA LCD modulation signal (Polarity change)
			Output low ”0”			0.22*VBB	V	
			Output current			2	mA	
			Frequency		10.8		kHz	
			Series resistance		200		Ω	
48	EARP O	COBBA_GJP	Maximum Output swing Vpp	2.36	2.5		V	Earpiece

Table 9. UI Connector (continued)

Pin	Signal Name Type	From/To	Parameter	Minimum	Nominal	Maximum	Unit	Function
47	EARN	COBBA_GJP	Maximum Output swing Vpp	2.36	2.5		V	
			EARP/N Offset	–50		50	mV	
			Load resistance		32		Ω	
43, 44	SPKP	Audio Amp	Output level			1.8	Vrms	HF Speaker
45, 46	SPKN	Audio Amp	Output level			1.8	Vrms	
			Load resistance		8		Ω	

System – RF interface

Table 10. AC and DC Characteristics of signals between RF and System blocks

Signal name	From	To	Parameter	Minimum	Typical	Maximum	Unit	Function
VBATT	Main battery	PA	Voltage	3.0	3.6	4.8	V	PA supply voltage
VREF	CCONT (VREF)	RF (HAGAR)	Voltage	1.478	1.5	1.523	V	Reference voltage for RF
VXO	CCONT (VR1)	VCTCXO	Voltage	2.7	2.8	2.85	V	Supply voltage for VCTCXO
VSYN_1	CCONT (VR4)	Vdd_bb, LNAs	Voltage	2.7	2.8	2.85	V	Supply voltage for LNAs and Vdd_bb
VSYN_2	CCONT (VR3)	HAGAR, VCO	Voltage	2.7	2.8	2.85	V	Supply voltage for dividers, LO buffers, prescalers and VCO
VCP	CCONT (5V5)	Charge pump regulator	Voltage	4.8	5.0	5.2	V	Supply voltage for PLL charge pump regulator
VRX	CCONT (VR2)	HAGAR	Voltage	2.7	2.8	2.85	V	Supply voltage for LNA2 + mixer + DTOS
VTX	CCONT (VR5,VR7)	HAGAR	Voltage	2.7	2.8	2.85	V	Supply voltage for TX modulator
HAGARRSTX	MADLinda	HAGAR	Output high ”1”	0.8*VBB		VBB	V	HAGAR reset, active LOW
			Output low ”0”	0		0.22*VBB	V	
			Output Current			2	mA	
SENA1	MADLinda	HAGAR	Output high ”1”	0.8*VBB		VBB	V	HAGAR synthesizer interface enable
			Output low ”0”	0		0.22*VBB	V	
			Output Current			2	mA	
SDATA	MADLinda	HAGAR	high ”1”	0.8*VBB		VBB	V	HAGAR synthesizer interface control data
			low ”0”	0		0.22*VBB	V	
			Output Current			2	mA	
			Data rate		3.25		Mbit/s	

Table 10. AC and DC Characteristics of signals between RF and System blocks (continued)

Signal name	From	To	Parameter	Minimum	Typical	Maximum	Unit	Function
SCLK	MADLinda	HAGAR	Output high "1"	0.8*VBB		VBB	V	HAGAR synthesizer interface clock
			Output low "0"	0		0.22*VBB	V	
			Output current			2	mA	
			Clock rate		3.25		MHz	
AFC	COBBA_GJP	VCTCXO	Voltage	0.046		2.254	V	Automatic frequency control signal for VC(TC)XO
			Resolution	11			bits	
			Load resistance (dynamic)	10			kΩ	
			Load resistance (static)	1			MΩ	
RFC	VCTCXO	MADLinda	Frequency		13		MHz	High stability clock signal from RF block,
			Signal amplitude	0.5	1.0	2.0	Vpp	
			Load resistance	10			kΩ	
			Load capacitance			1	nF	Series capacitance
RXIP	HAGAR	COBBA_GJP	Output level		300	1400	mVpp	Single ended in–phase RX signal to baseband
			Input impedance		1		MΩ	
			Input capacitance		8		pF	
RXQP	HAGAR	COBBA_GJP	Output level		300	1400	Vpp	Single ended quadrature RX signal to baseband
			Input impedance		1		MΩ	
			Input capacitance		8		pF	
RXREF	COBBA_GJP	HAGAR	Output Voltage	1.15	1.2	1.25	Vpp	Reference voltage for RX signals
			Output Impedance		3	200	Ω	
			External serial load	9			kΩ	
			Load Current		100		μA	– sink or source
TXIP/ TXIN	COBBA_GJP	HAGAR	Differential voltage swing	1.022	1.1	1.18	Vpp	Differential in–phase TX baseband signal for the TX I/Q modulator
			DC level	1.165	1.2	1.235	V	
			Output impedance			500	Ω	

Table 10. AC and DC Characteristics of signals between RF and System blocks (continued)

Signal name	From	To	Parameter	Minimum	Typical	Maximum	Unit	Function
TXQP/TXQN	COBBA_GJP	HAGAR	Differential voltage swing	1.022	1.1	1.18	Vpp	Differential quadrature phase TX baseband signal for the TX I/Q modulator
			DC level	1.165	1.2	1.235	V	
			Differential offset voltage (corrected)			+/– 2.0	mV	
			Diff. offset voltage temp. dependence			+/– 1.0	mV	
			Output impedance			500	Ω	
TXP	MADLinda	HAGAR	Output high ”1”	2.1		2.9	V	Transmitter power control enable
			Output low ”0”	0		0.8	V	
			Output Current			2	mA	
TXC	COBBA_GJP	HAGAR	Voltage Min level	0.12		0.18	V	Transmitter power control voltage
			Voltage Max level	2.27		2.33	V	
			Output impedance active state			200	Ω	
			Output impedance power down state	high Z				
			External resistance	10			kΩ	
			External capacitance			10	pF	
			Settling time			10	µs	

Functional Description

Modes of Operation

There are three main operation modes in the system when power is on:
– Running
– Idle
– Deep Sleep

Note that phone can be either on or off in each of power on states.

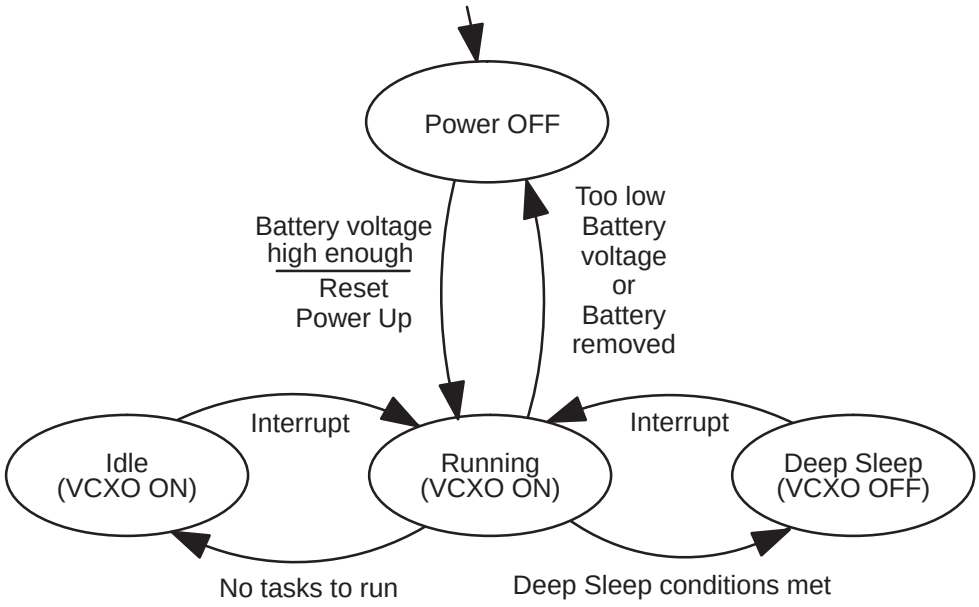

Figure 3. Basic Operation Modes of RAE-3 (simplified scheme)

Power saving modes are entered under SW control. Returning to running mode is activated by interrupt (generated internally by MADLinda or from CCONT).

Clocking Scheme

The 26MHz main clock frequency is generated by the VCTCXO located in the RF section. This clock is divide in HAGAR to 13MHz. Clock signal is buffered to low level sine wave clock signal (RFC) and fed to system HW side. There it is connected to MADLinda clock input. The MPU within MADLinda can stop the clock by shutting off the VCTCXO's supply voltage (VXO) via CCONT.

The CCONT provides a 32kHz sleep clock generated from 32.768kHz quartz crystal. This clock signal is used internally in CCONT to run the RTC and routed to MADLinda (SLEEPCLK). Sleep clock is used to run MADLinda when the main clock is shut down. A backup battery keeps the RTC running if the main battery is disconnected.

Other clock signals are generated inside MADLinda using PLLs and clock dividers which are controlled by SW. The maximum clock frequency in the MPU side is 52MHz and in the DSP side 78MHz.

Power Control and Reset

In normal operation the system HW is powered from the main battery. An external charger can recharge the battery while also supplying power to RAE-3. The supplied charger, ACP–12, can deliver 850mA.

The power management circuitry provides protection against over–voltages, charger failures and pirate chargers etc. that would otherwise cause damage to RAE-3.

Following chapters give an overview about power management issues.

Power Distribution

Figure 4 describes the power distribution of RAE-3.

Power supply components – CCONT, VBB, Vcore, VACC and VMMC regulators – and the audio amplifier are powered with main battery voltage. Main battery voltage is also fed to RF part for RF power amplifier (PA) and to the UI module for backlight and LCD supply.

Separate linear regulator generates the 2.8V VBB power supply. VBB powers most of the system HW portions including MADLinda, SDRAM, DOC and Serial Flash memories, COBBA_GJP's digital supply and the logic parts of the IR transceiver. It also supplies 2.8V to the UI module.

Separate DC/DC regulator generates the 1.8V Vcore voltage. Vcore is used as supply for the MADLinda and XIP memory core voltage and as IO voltage for XIP and DOC memories.

CCONT's V2V output is used as enable for VBB and Vcore regulators.

VSIM regulator of CCONT is used to generate either 3V or 5V supplies for SIM card. This is required so that RAE-3 can support both 3V and 5V SIM cards.

VR6 generates the voltage for COBBA_GJP's analogue part.

CCONT generates the reference voltage VREF for COBBA_GJP and HAGAR. It also generates the 5V supply voltage (V5V) for RF. In RF side there is separate regulator that drops this voltage to 4.7V for DCT4 RF use.

Regulators VR1 to VR5 inside CCONT generate voltages for RF HW. Regulator control signals come from MADLinda.

Separate 3V linear regulator is used to power the MMC card.

Another 3V linear regulator is used to generate accessory power that can be fed through system connector for external accessory.

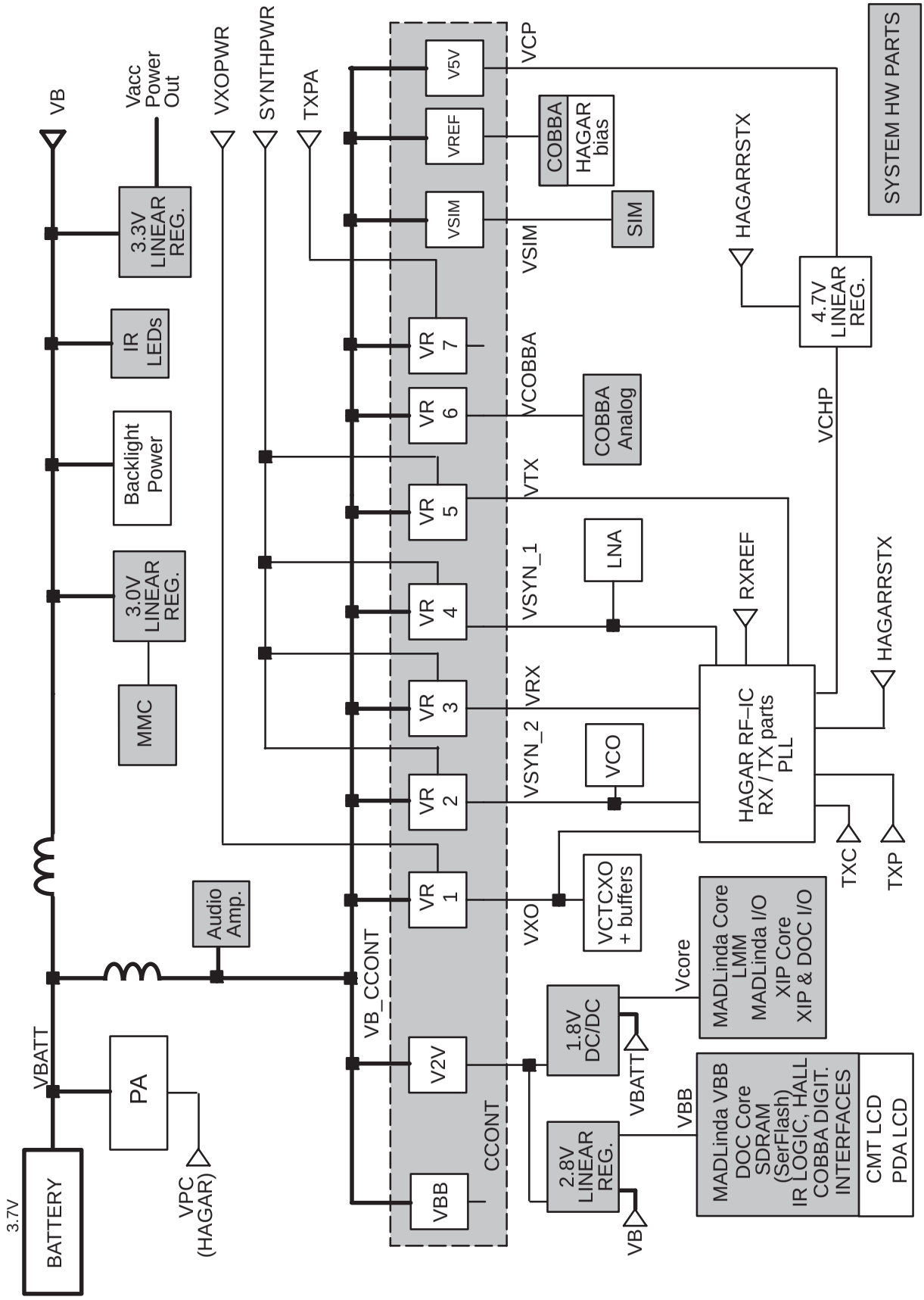

Figure 4. Power Distribution

Power up

When main battery is connected to device, powering on circuitry keeps CCONT PWRONX/WDDISX pin connected to ground through10kΩ resistor as long as CCONT releases the PURX reset signal. This activates the CCONT immediately when battery is connected.

When the CCONT is activated, it switches on internal baseband and core regulators and generates a power up reset signal PURX for MADLinda. External Vcore and VBB regulators are powered up, Vcore slightly before VBB.

After 62ms CCONT releases the PURX reset signal. When the PURX is released, MADLinda releases the system reset (ExtSysResetX), the Flash reset (FLRPX) and internal reset signals and starts the boot program execution. Note that from battery plug in to PURX release it takes about 100ms since there is no power in CCONT.

The GenSDIO pin is connected low with pull–down resistor so that booting starts from MADLinda's internal boot ROM. If booting is successful (and the programming device is not connected) the program execution continues from external program memory.

The CMT power switch (on the cover) is read as a normal keyboard input. It is not connected to CCONT. CMT Power switch only turns the phone functionality on or off (SW implementation).

Power Off

RAE-3 electronics is powered off only if the main battery voltage drops below the power off SW limit. This happens when the main battery discharges or is removed. When battery voltage drops below SW limit, CCONT is powered down by letting CCONT's watch dog to go off.

Early warning of battery removal is generated by the battery removal switch. Switch connects MADLinda's MPUGenIO6 to ground when user presses the locking latch of the battery.

Only phone functionality is "powered off" when the CMT power switch is pressed. If the main battery is removed when the CMT is on, the SIMIF in MADLinda powers down the SIM.

Charging

Charging of main battery can be started in any operating mode. The battery type and capacity are identified by MADLinda by measuring a pull–down resistor connected to BSI contact inside the battery pack. Charging software running in MADLinda's MPU measures the battery voltage, size, current and temperature.

In Standard charger concept (2–wire charger) the power management circuitry controls the charging current delivered from the charger to the main battery. The charging–current switch inside CHAPS is controlled with 1Hz PWM signal, generated by CCONT. Note that Standard charger is not sold with RAE-3, but it is accepted.

In performance charging concept (3–wire charger) a 32Hz PWM signal is fed to the charger (CHRG_CTRL in system connector). This high rate keeps the charging–current switch in CHAPS continuously connected.

The PWM pulse width is controlled by the MPU in MADLinda which sends a control value to CCONT through a serial control data bus. The main battery voltage rise is limited to a specified level by turning the switch off. Lower limit (4.8V) in CHAPS is permanently selected because only lithium batteries are supported. Charging current is monitored by measuring the voltage drop across a sensor resistor.

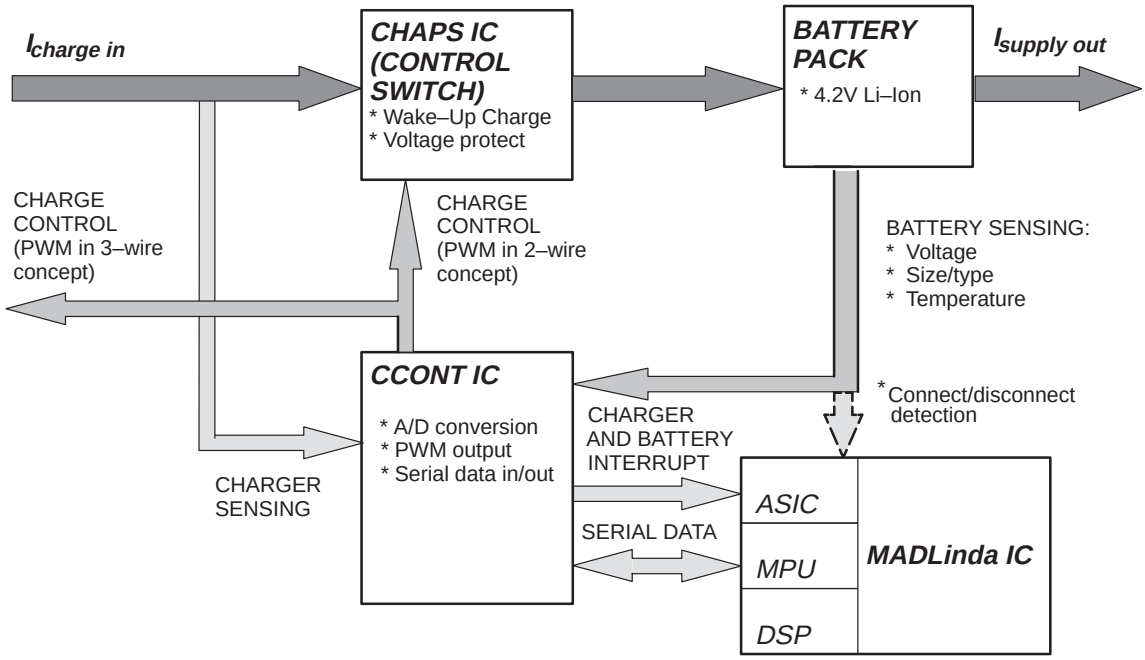

Figure 5. Block diagram of charge control in RAE-3

Resets and Watchdogs

Power–up reset signal, PURX, is the main reset in RAE-3. PURX is generated by CCONT during power–on. The watchdog within CCONT is enabled and must be fed periodically to keep CCONT (and whole device) powered on. PURX –signal is connected to MADLinda's reset input (PURX). Figure 6 shows the board/module level reset scheme in RAE-3.

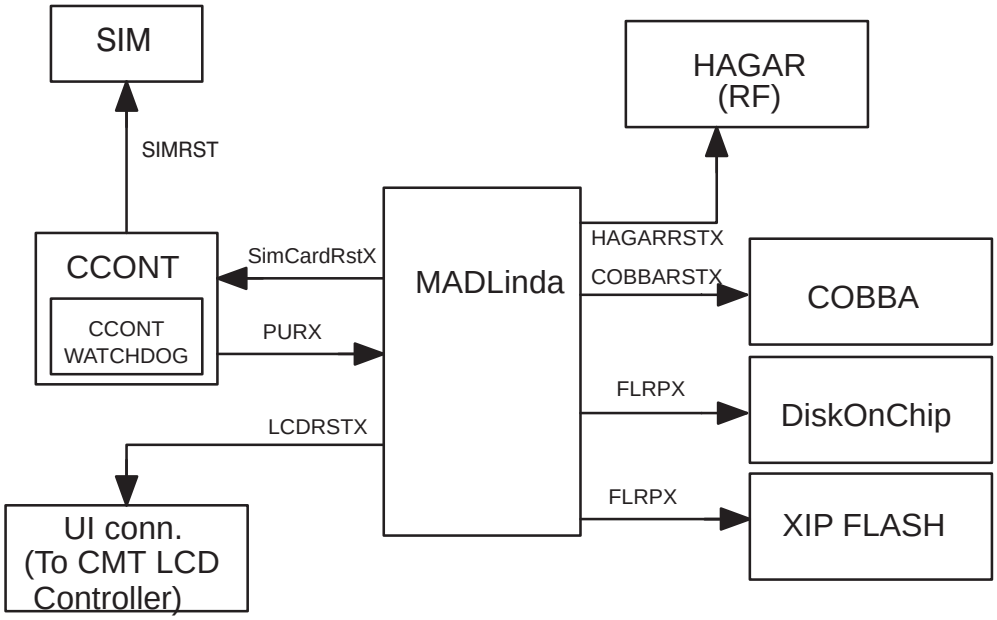

Figure 6. Board/Module level reset scheme

PURX resets the whole MADLinda. ExtSysResetX signal follows PURX activity during reset. After reset this signal can be configured as IO and thus controlled by SW with MPUGenOut8 control bit.

The LCD driver reset signal (LCDRSTX) is a MADLinda general purpose output controlled by MPU SW.

Flash memory interface in Traffic Controller's MEMIF block includes Flash reset/power down signal (FLRPX). FLRPX signal follows PURX activity during reset. After reset this signal can be controlled by MPU SW. Signal is connected to XIP Flashes.

MADLinda's SIM interface block generates the reset signal (SimCardRstX) for the SIM. This signal is fed through CCONT, which makes any level shifting necessary according to the voltage level of the SIM card in use.

COBBA_GJP reset signal (COBBARSTX) is DSPGenOut0 general purpose output controlled by DSP SW. Reset state of the pin is LOW.

HAGAR reset signal (HAGARRSTX) is DSPGenOut1 general purpose output controlled by DSP SW. Reset state of the pin is LOW.

System to interface

In following chapters the blocks of system HW in SYSTEM part of KL8 schematics and functions related to each interface are described.

The blocks include: CPU, MEMORIES, MMC, IRDA, UI, SYSCON, AUDIO_RFI and POWER.

Component placement diagrams are in the A3 section.

CPU block

Main components in the CPU block comprise:
– MADLinda ASIC (D300), package 240 µ*BGA
– Hall switch TLE4916 (V301)

MADLinda is the main ASIC for RAE-3's single processor system. MADLinda is used as engine processor for both CMT and PDA functions. The pins are not listed because it is not possible to access them except at measurement points.

Hall sensor switch is used to detect lid position (open/close). Magnet for detection is in lid part of RAE-3. Hall device's open drain output is pulled up with external 100kΩ resistor (R302). Output goes to low state when the sensor is not in magnetic field (lid open).

MEMORIES block

Main components in the block are:
– two 4Mx16 (64Mbit) Flash memories (D351, D352)
– DOC 16MB (128Mbit) flash memory (D353)
– SDRAM 4Mx16 (64Mbit) (D350);
– Serial Flash 32Mbit (D354); – Serial flash is not assembled to kl8 module

XIP Memories

The directly executable MPU program code resides in two XIP Flash memories.

In Assembled device when 1.8V IO–line is connected to VPP –pins, Flash devices consider the high level as program enable and actual programming current is taken from Vcc pin of Flash. Vpp connection scheme is shown in Figure 7.

Reset state of MPUGenIO1 protection signal is low so writing/programming is initially disabled.

Flashes are 8Mbyte (4Mx16) 70ns/52MHz synchronous burst mode devices packed in 56 pin CSP (µBGA56).

XIP memories are fully supplied from 1.8V Vcore voltage.

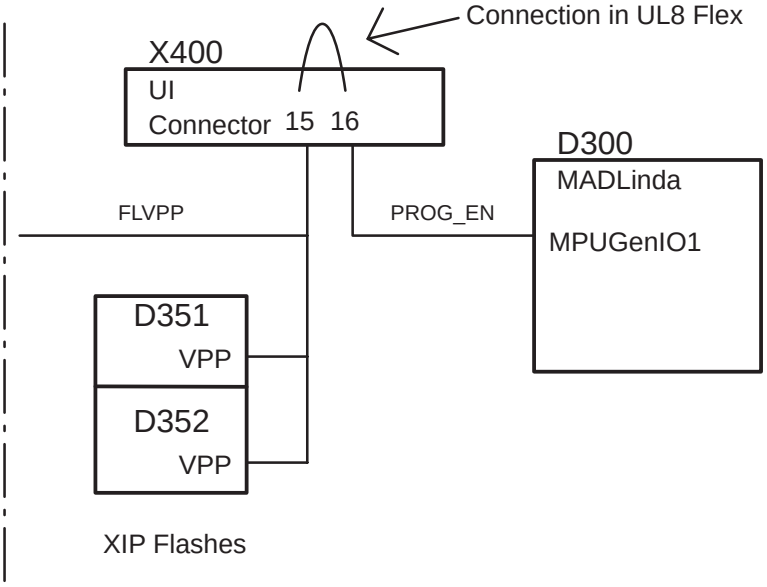

Figure 7. XIP Flash Vpp connection

SDRAM Memory

Synchronous DRAM is used as working memory and PDA display buffer memory. MADLinda has a separate 16 bit wide interface for SDRAM device. Interface supports also byte accesses. Supported memory clocking speeds are 13MHz and 52MHz. MADLinda can execute code also from SDRAM.

The SDRAM is 64Mbits (8Mbyte) 104MHz device in 52–pin CSP (WBGA52). Organisation of the memory is 4Mx16 with byte accesses possibility. Nominal supply voltage Vcc is 2.8V and it is supplied from the common VBB voltage.

SDRAM supports self refresh mode. This mode is used in Deep Sleep mode when all clocks are off to preserve SDRAM data. All memory contents are lost when memory is un–powered, so when the battery is removed or the battery voltage drops under the power off voltage.

DOC memory

DiscOnChip memory is used as Flash file system memory. It is used partly as user memory and partly to hold applications.

The DOC device comprises 128Mbit NAND–type flash memory array and a memory controller inside.

Used DOC memory is a16MByte Mobile DiscOnChip device in 63–ball LFRBGA.

Core voltage for the DOC is supplied from 2.8V VBB and I/O voltage from 1.8V Vcore.

MMC block

Main components in MMC block are:
– MMC connector (X001)
– ESD protection zener array (V001)

MMC mode type serial interface to Memory Card is controlled by the MMC interface block in MADLinda. The MMC interface includes two serial lines, command and data, and one clock line that is used to clock serial transfers in both lines. Used clock frequency is 13MHz.

SPI mode Memory Cards are not supported in RAE-3.

Memory Card is powered with 3.0V supply using controllable regulator.

Mechanical switch is used to indicate when the lid covering the Memory Card (and SIM) is opened. Switch is integrated to RAE-3 B–cover mechanics. In KL8 there is only contact pad J001 for the signal.

Hot swap as specified in Memory Card System Specification is not supported. MultiMedaCard must be powered off (VMMC turned off) when lid is opened.

IRDA block

Main component in IRDA block is the IR transceiver TFDU5102 (N050).

Data transmitting and receiving through IR interface is handled by IrDA block inside MADLinda. MPU controls the interface.

UI block

Components in UI block include:
– Board–to–board UI connector (X400)
– Integrated EMI/ESD filtering components (Z400, Z401, Z402, Z403, Z404)

QWERTY –flex module UL8 is connected to UI connector. DL1 UI module is connected to system HW through UL8.

Phone LCD Interface

Phone LCD interface is controlled by MPU using LCDSIO part of MADLinda's internal UIF block. This same serial control interface is used also to command the CCONT. Phone LCD resetting and backlight control of LCD and phone keys are controlled by MPU using signals from MADLinda's GPIO.

Keyboard Interface

Keyboard interface is controlled by MPU using programmable I/O block inside MADLinda. I/O signal matrix is used to read both PDA keyboard (qwerty and soft keys) and phone keypad.

To detect the key press ROWs are programmed to give interrupt when any of the keys is pressed. After key press detection SW polling is used to find out pressed key.

Earpiece and HF Speaker lines

Earpiece and speaker lines come from the AUDIO_RFI block.

Battery removal signal

BATT_REM signal comes from the battery removal switch.

SYSCON block

Main components in system connector block include:
– System connector (X450) (pads for system connector’s spring contacts)
– Coaxial connector for antenna cable (X499)
– ESD protection zener array (V451)

For protecting the communicator against ESD spikes and EMI at the system connector, all lines are equipped with TVS and filtering devices located next to the system connector.

The system connector includes the following group of contacts:

– DC jack for external plug–in charger and contacts for desktop charger
– Contacts for external audios
– Contacts for serial connections
– External RF connector with switch

Externally, the system connector resembles the system connector in N9110 Communicator. Figure 8 shows the pads on PWB and Figure 9 shows the connector. Serial connection signals are named in RAE-3’s connector according to DCE type equipment (as in RAE–2). This means that DCE_RX and DCE_DCD (MBUS line) are outputs and DCE_TX and DCE_DTR are inputs.

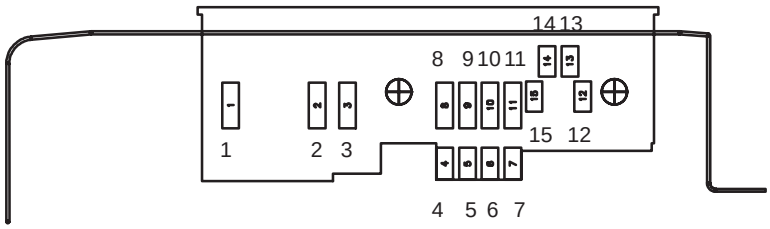

Figure 8. Pads for system connector on top side of KL8

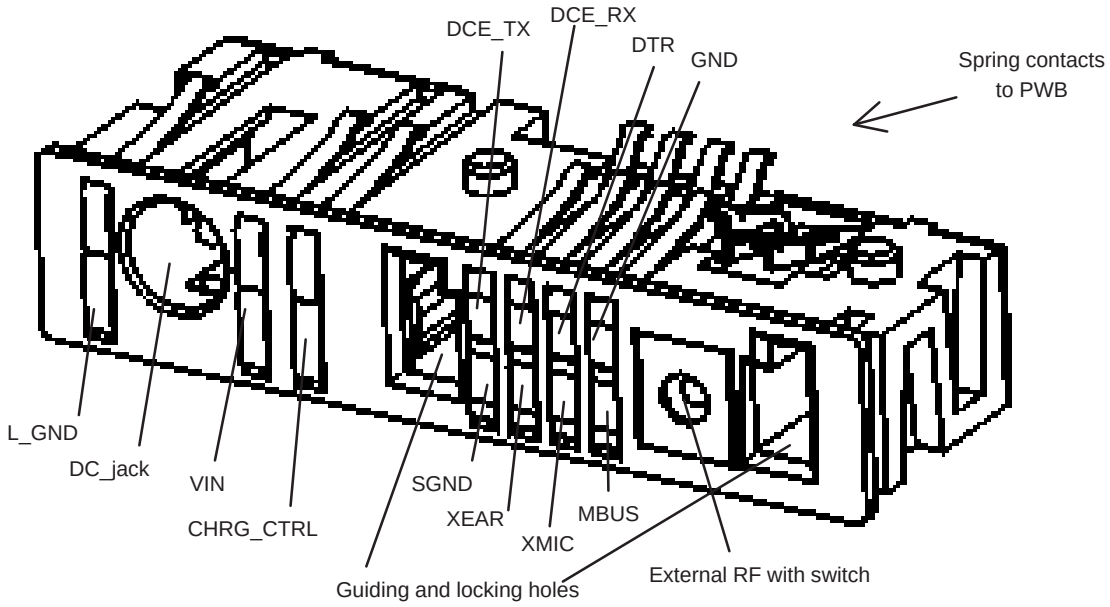

Figure 9. System Connector

Serial connections

Serial interface signals are MBUS (DCE_DCD) [MBUS], DCE_RX [AccTxData], DCE_TX [AccRxData] and DCE_DTR [DTR]. First name is the contact name in the system connector and in square brackets is given the signal name used in schematics. Note that all these signals are logic level signals thus interface buffering/level sifting according some serial interface standards is done outside RAE–3.

MBUS is normally connected to PUP USART. When PUP USART is selected to be connected to transmit and receive lines (FBUS use) MBUS is not usable as a serial signal. In synchronous mode MBUS is used as USART's clock input. Synchronous mode is used in Flashing.

DTR handshaking input is connected to MPUGenIO0. Accessory power output (VACC) is also fed through the DCE_DTR pin. Diode V489 prevents cable's signal output to supply power to KL8, when main battery is not connected, and accessory power regulator to supply 3V directly to MADLinda's input. Pullup R310 is thus needed to generate the high level state of DCE_DTR input to MPUGenIO0.

External Audio Interface

External audio signals, XMIC and XEAR, come from AUDIO_RFI block (see p.38). An external headset accessory, car kit or loop set can be connected to the external audio lines. External audio lines are also used to detect different accessories.

Charger Interface

Charger voltage input line V_IN is connected through 1.5A fuse (F450) to CHAPS (charger control) ASIC's VCH inputs. Divided (47k/4k7) V_IN voltage level is connected to CCONT's VCHAR ADC input.

Charger controlling PWM output line, CHRG_CTRL, comes from CCONT's PWM output (PWM_OUT).

External RF

External RF signal comes from RF section of KL8. RF connector in system connector includes switch for external/internal signal routing. When external RF plug is not connected to the system connector, RF signal is connected to coaxial antenna cable connector (X499).

POWER block

Power block includes following functions:
– supply voltage generation for system and RF parts and 2.8V to UI
– control of main battery charging
– power on and power off controlling and reset generation
– RTC and RTC backup control
– sleep clock generation
– SIM interface
– A/D conversions
– powering of Memory Card
– Accessory power output generation (through System Connector)

Main components in power block are:
– CCONT2M power ASIC (N100)
– CHAPS charging control ASIC (N101)
– Linear regulator (N102) for VBB
– DC/DC switching regulator (V105) for Vcore
– Linear regulator (N103) for Memory Card powering (VMMC)
– Linear regulator (N104) for Accessory power output (VACC)
– FET (V108) for control of regulators N102 and V105
– 32.768kHz crystal oscillator (32k XTAL B100)
– 2.7V reset device (D101), NC7SZ175 D–flip–flop (D102) and fets (V102, V106) for power on & off control
– 2.0V reset device (D100) for backup disconnection
– ESD protection zener array (V103) for SIM interface
– 2–pin connector (X102) for backup battery (contacts for positive terminals)
– Battery connector (X100) for main battery
– SIM card connector (X101)

Clocking, powering, charging and reset issues of CCONT and CHAPS are covered in separate chapters .

Backup battery is connected to CCONT's VBACK input and it is charged from CHAPS' VBACK supply. Backup battery's positive contacts are made so that VBACK from CHAPS is connected to CCONT only when the battery is installed to the connector X102. Backup battery is located on top of RF shield A501 and grounded through the shield.

2.0V reset device (D100) disconnects backup battery if it's voltage drops too much. This prevents deep discharging which would permanently harm the backup battery.

3.0V VMMC supply voltage for Memory Card is generated with linear regulator (N103) from filtered battery voltage (VB). Regulator is controlled with the MMC_PWR signal from MADLinda MPUGenIO5.

Accessory power output (VACC) through the system connector's DCE_DTR line is generated with 3.0 volts linear regulator (N104) from filtered battery voltage (VB). Regulator's feed back resistor are internally disconnected from the output pin when the regulator is not enabled, so output will not affect DCE_DTR line's normal signal usage. VACC regulator is controlled with VACC_CTRL –signal from MADLinda's MPUGenOut1. .

Use of CCONT ADC channels

Following table describes the analogue signals measured with CCONT's A/D converter.

Table 11. ADC in CCONT

PIN no.	CCONT PIN NAME	CONNECTED SIGNAL	MEASURES	ADC input range
A1	RSSI		Not used	0.1V .. Vref
B1	ICHAR	–	Charger current measured through a 0.22Ω resistor X101	0.1V .. VBAT+0.4V
D2	VBAT	VB_CCONT	Main battery voltage	0.1V .. VBAT
A3	VCHAR	V_IN	Charger voltage (through voltage division)	0.1V .. Vref
D5	VCXOTEMP		Not used	0.1V .. Vref
B3	BSI	BSI	Main battery size indicator	0.1V .. Vref
C4	BTEMP	BTEMP	Main battery temperature	0.1V .. Vref
A2	EAD	HEADDET	External accessory detect – HEADDET	0.1V .. Vref

The type of the connected main battery is identified from the BSI line's voltage level. This voltage is formed by the system HW's pull–up resistor (100kΩ) and battery back's pull–down resistor. Level is read with CCONT's BSI A/D input.

The BSI contact on the battery connector is also used to detect when the battery is being removed to be able to shut down the operations of the SIM card before the power is lost. The BSI contact is shorter than the supply power contacts so this contact breaks first when the battery pack is removed, giving some time for the shut–down operations.

The temperature of the main battery is read from the BTEMP line's voltage level. This voltage is formed by the system HW's pull–up resistor (100kΩ) and battery pack's NTC resistor. Level is read with CCONT's BTEMP A/D input.

AUDIO_RFI block

The function of the AUDIO_RFI block is to interface between the digital world of the System Hardware and the analogue world of the audio and RF stages.

Main components include:
– COBBA_GJP (N200)
– Hands free audio amplifier (N201)
– FET (V200) for amplifier shut down control
– V202 for mic lines' EMI filtering/ESD protection

COBBA_GJP is a combined AUDIO– and RF–codec for phones with serial RF TxIQ & RxIQ data lines and serial control interface.

RFI

COBBA_GJP handles the following RFI functions:
– IF receiving with I/Q separation and A/D conversion (RxI, RxQ)
– I– and Q–transmit and D/A conversion (TxI, TxQ)
– transmit power control (TXC) D/A conversion
– Automatic frequency control (AFC) D/A conversion

Digital communication between COBBA_GJP and MADLinda is handled by MADLinda's SerialMFI block which controls both serial RF TxIQ and RxIQ data transfer and COBBA's control interface.

Audio

RAE-3NU* includes both normal phone audio and personal handsfree (PHF) audio functionality. Handsfree mode is implemented by speaker and normal mode by earpiece. Speaker and earpiece are not located on the KL8 module. Signals for speaker and earpiece are passed through the UI connector. Only one high sensitivity microphone will be used for both modes. On the KL8 module there are contacts pads (P200, P201) where microphone is connected with spring contacts.

Analogue to digital conversion (ADC) of RAE-3's microphone signals and digital to analogue conversion (DAC) of received audio signals (for speakers) are done in COBBA_GJP. Input and output signal source selection and gain control is performed inside the COBBA_GJP according to control messages from MADLinda. Audio tones are generated and encoded by MADLinda and transmitted to COBBA_GJP for decoding. PCM coded digital audio data is moved between MADLinda's DSP and COBBA_GJP through the PCM bus. The audio functions in COBBA_GJP are controlled through the serial control interface from MADLinda's SerialMFI block. DTMF and keypad tones are routed to earpiece, while ringer, wav and handsfree audios are routed to handsfree speaker.

External audio signals, XMIC and XEAR, come from system connector. XMIC is connected to COBBA_GJP's MIC1N and MIC3N inputs through DC blocking capacitors. Reference for XMIC is SGND. XEAR is connected to COBBA_GJP's HF output through DC blocking capacitors. Reference for XEAR is GND.

Audio amplifier IC (N201) is used to amplify the HF output signal of COBBA_GJP for the personal hands free speaker. Audio amplifier shut down mode is controlled with MADLinda's MPUGenOut0 line. Because HF amplifier is powered from battery voltage, controlling of shut down is done through pull–down fet (V200).

HeadDet and HookDet interrupting inputs in MADLinda are used to detect different audio accessories. EAD A/D input in CCONT is used to detect the removal of accessory during call.

Figure 10 describes the audio connections in system HW.

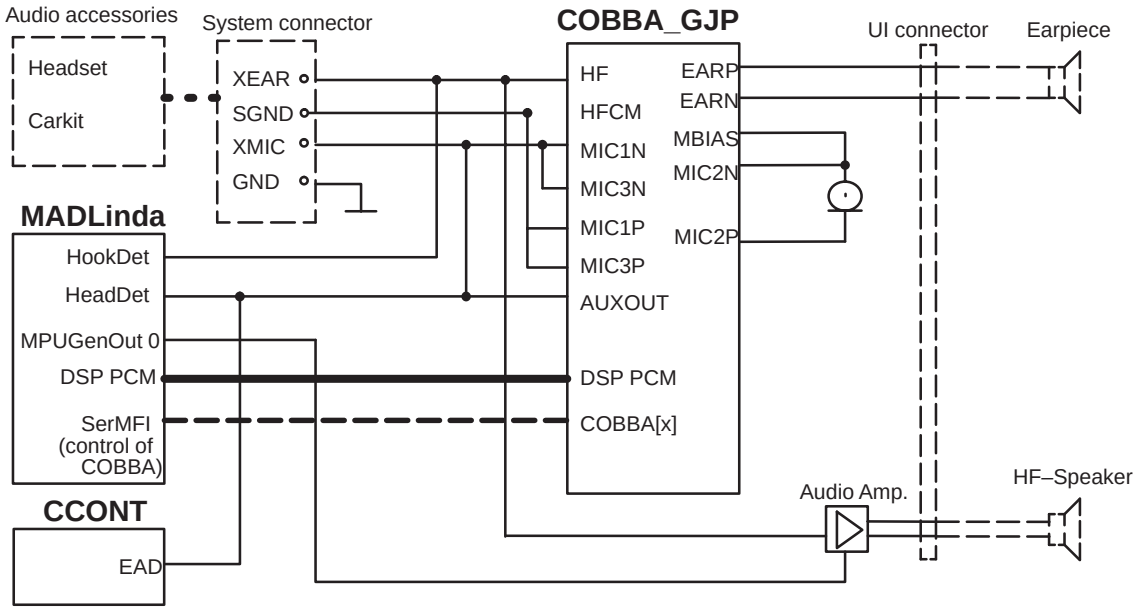

Figure 10. Audio connections in KL8

Introduction to RF of KL8

Maximum ratings

Table 12. Maximum ratings of RF block

Parameter	Rating
Max battery voltage (VBATT), idle mode	4.2 V
Max battery voltage during call, highest power level	4.2 V
Regulated supply voltages (VXO, VSYN_1, VSYN_2, VTX, VRX)	2.8 +/– 3% V
PLL charge pump supply voltage (VCP)	4.8 +/– 0.2 V
Voltage reference (VREF_2)	1.5 +/– 1.5% V
Voltage reference (RXREF)	1.2 +/– 0.05 V
Operating temperature range (Transceiver ambient)	–10...+55 °C

RF frequency plan

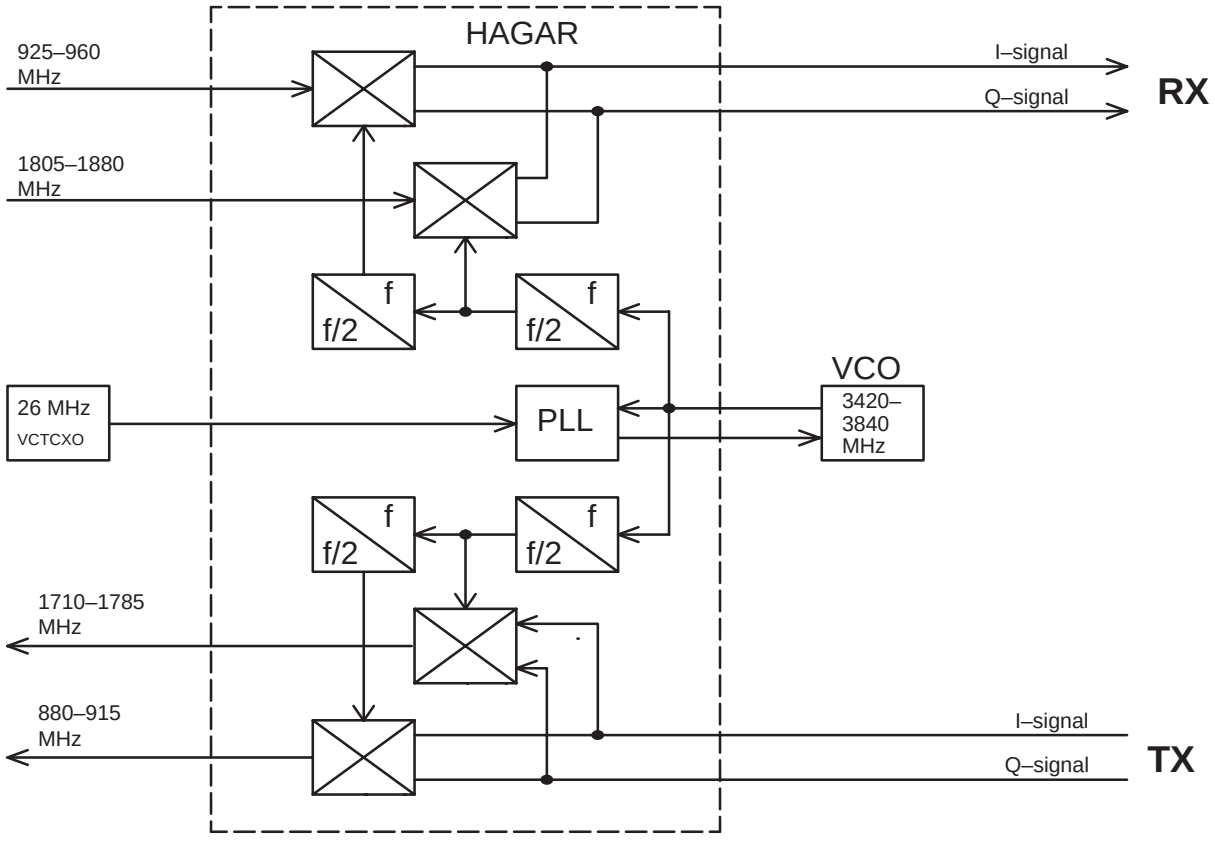

Figure 11. RF Frequency plan

DC characteristics

Regulators

Transceiver includes a multi function power management IC (CCONT), which contains among other functions also 7 pcs of 2.8 V regulators. All regulators

can be controlled individually with 2.8 V logic directly or through control register. The regulator IC is located in the system block of the transceiver.

Use of the regulators is illustrated in the power distribution diagram Figure 12.

VREF_2 from CCONT IC and RXREF from COBBA IC are used as the reference voltages for HAGAR RF–IC, VREF_2 (1.5V) for bias reference and RXREF (1.2V) for RX ADC's reference.

Control signals

This table shows used control signals for different functions and the typical current consumption (VBATT = 3.7 V). All regulators except VXO are switched on and off using the SYNTPWR control signals. The TX and RX blocks are switched on and off under HAGAR control. These controls are accessed via serial interface from MADLinda to HAGAR.

Table 13. Control signals and current consumptions (Measurements fo curremts)

VCXOPWR	SYNTHPWR	TXP	Typical current consumption	Notes
H	H	L	22 mA	Synthesizers
H	H	L	116 mA	RX active
H	H	L	171 mA	TX active except PA
H	H	H	1092 mA	TX active, PL5 to 50 ohm

All regulators which are connected to HAGAR are enabled simultaneously by SYNTHPWR. In different modes the loads are switched on and off using HAGAR's serial bus.

All control signals are coming from MADLinda and they are 2.8 V logic signals.

List of the needed supply voltages:

Table 14. Supply voltages

Voltage source	Supply name	Load
VR1	VXO	VCTCXO, Hagar (VDIGI)
VR2	VRX	HAGAR (VRF_RX, VF_RX)
VR3	VSYN_2	HAGAR (VLO, VPRE)
VR4	VSYN_1	HAGAR (VBB), LNA's
VR5	VTX	HAGAR (TX modulator)
VR6		COBBA
VREF_2		HAGAR (VB_EXT)–voltage ref.
RXREF		HAGAR (VREF_RX)–voltage ref.
V5V	VCP	VCO, HAGAR (VCP)
TXVGSM (HAGAR)		Antenna switch GSM
TXVDCS (HAGAR)		Antenna switch DCS1800
TXVDET (HAGAR)		Power detector
Battery	VBATT	RF–regulators in CCONT, PA's

4.7 V regulator in VCP line

The function of the regulator is to be a DC switch.

The RESET line controls regulator's output and makes sure that there is no Vchp voltage if the reset is active (low).

Power distribution diagram

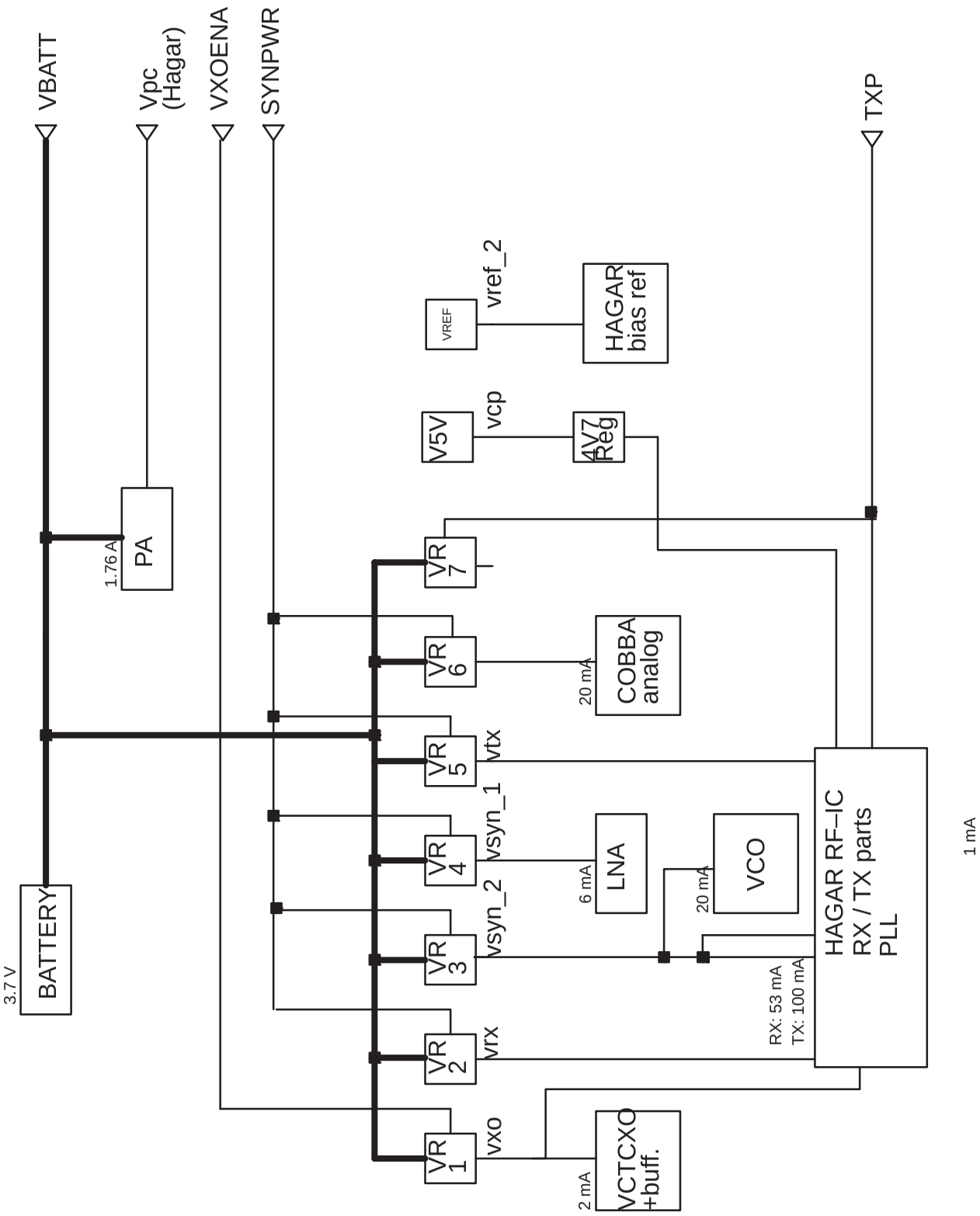

Figure 12. Power distribution diagram

RF characteristics

Table 15. Main RF characteristics

Item	Values / E–GSM	Values / DCS1800
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	200 kHz
Number of RF channels	174	374
Power class	4	1
Number of power levels	15	16

Transmitter characteristics

Table 16. Transmitter characteristics

Item	Values / E–GSM	Values / DCS1800
Type	Direct conversion, dual band, nonlinear, FDMA/TDMA	
LO frequency range	3520 ... 3660 MHz	3420 ... 3570 MHz
Output power	+33 dBm (2.0 W) peak	+30 dBm (1.0 W) peak

Table 17. Output power requirements / E–GSM

Parameter	Min.	Typ.	Max.	Unit / Notes
Max. output power		33.0		dBm
Max. output power tolerance (power level 5)			+/– 2.0 +/– 2.5	dB, normal cond. dB, extreme cond.
Output power tolerance / power levels 6...15			+/– 3.0 +/– 4.0	dB, normal cond. dB, extreme cond.
Output power tolerance / power levels 16...19			+/– 5.0 +/– 6.0	dB, normal cond. dB, extreme cond.
Output power control step size	0.5	2.0	3.5	dB

Table 18. Output power requirements / DCS1800

Parameter	Min.	Typ.	Max.	Unit / Notes
Max. output power		30.0		dBm
Max. output power tolerance power level 0, (30dBm)			+/– 2.0 +/– 2.5	dB, normal cond. dB, extreme cond.
Output power tolerance / power levels 1...8, (28 ... 14 dBm)			+/– 3.0 +/– 4.0	dB, normal cond. dB, extreme cond.
Output power tolerance / power levels 9...13, (12 ... 4 dBm)			+/– 4.0 +/– 5.0	dB, normal cond. dB, extreme cond.
Output power tolerance / power levels 14 and 15, (2 and 0dBm)			+/– 5.0 +/– 6.0	dB, normal cond. dB, extreme cond.
Output power control step size	0.5	2.0	3.5	dB

Output power is measured from the external antenna connector. In the dual–slot mode the power levels of adjacent time slots must be individually and arbitrarily controllable.

Receiver characteristics

Table 19. Receiver characteristics

Item	Values / E–GSM	Values / DCS1800
Type	Linear, direct conversion, dual band, FDMA/TDMA	
LO frequencies	3700 ... 3840 MHz	3610 ... 3760 MHz
Typical 3 dB bandwidth	+/– 104 kHz	+/– 104 kHz
Sensitivity	min. – 102 dBm , S/N >8 dB	min. – 102 dBm , S/N >8 dB

Functional descriptions

RF block diagram

The block diagram of the direct conversion transceiver architecture used in KL8 is shown in Figure 13. The architecture contains one RF ASIC (HAGAR), dual–band PA module, VCO and VCTCXO modules, RF filters for TX and RX, and discrete LNA stages for both receive bands.

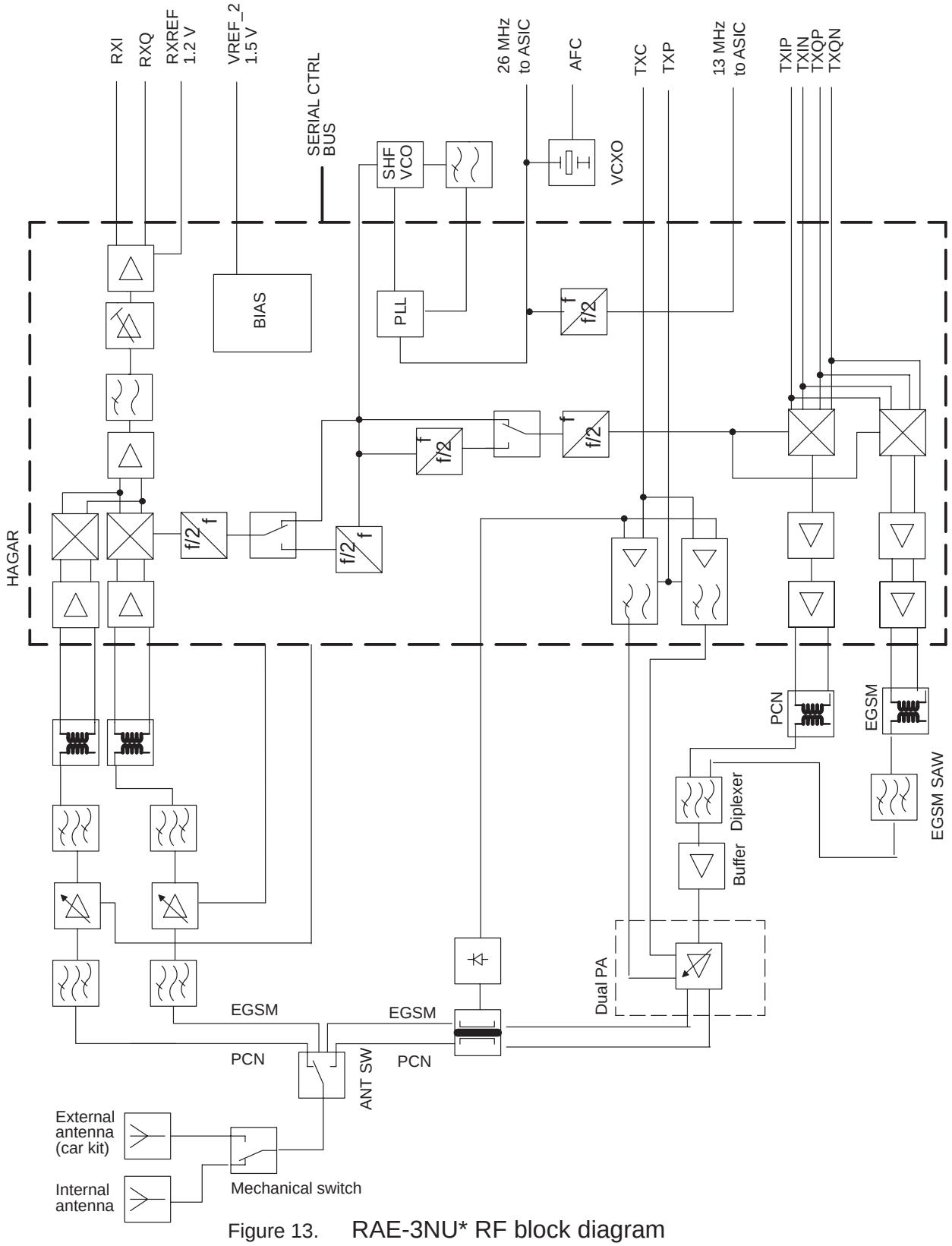

Figure 13. RAE-3NU* RF block diagram

Frequency synthesizer

VCO frequency is locked with PLL into stable frequency source, which is a VCTCXO–module . The VCTCXO is running at 26 MHz. The residual temperature, drift, Doppler and initial inaccuracy effects are compensated with AFC (automatic frequency control) voltage. The AFC locks the VCTCXO into frequency of the base station

PLL is located in HAGAR RF–IC and is controlled via serial bus from MADLinda–IC, which is located in the system block.

LO–signal is generated by SHF VCO module. VCO has double frequency in DCS1800 and x 4 frequency in E–GSM compared to actual RF channel frequency. LO signal is divided by two or four in HAGAR (depending on system mode).

Receiver

Receiver is a direct conversion, dualband linear receiver. Received RF–signal from the antenna is fed via RF–antenna switch to 1st RX dualband SAW filter and discrete LNAs (low noise amplifier). There are separate LNA branches for EGSM900 and DCS1800.

After the LNA amplified signal (with low noise level) is fed to bandpass filter (2nd RX dualband SAW filter).

These bandpass filtered signals are then balanced with baluns. Differential RX signal is amplified and mixed directly down to BB frequency in HAGAR. Local oscillator signal is generated with external VCO. VCO signal is divided by 2 (DCS1800) or by 4 (EGSM900). PLL and dividers are in 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.

Next stage in the receiver chain is AGC–amplifier, also integrated into HAGAR. AGC has digital gain control via serial mode bus from MADLinda IC.

Single ended filtered I/Q–signal is then fed to ADCs in COBBA–IC. Input level for ADC is 1.4 Vpp max.

Transmitter

Transmitter chain consists of final frequency I/Q–modulator, dual–band power amplifier and a power control loop.

I– and Q–signals are generated by baseband also in COBBA_GJP ASIC. After post filtering (RC–network) they go into IQ–modulator in HAGAR. After modulator the TX–signal is amplified and buffered. There are separate outputs for both E–GSM and DCS1800. HAGAR TX output level is +3 dBm minimum at 2.8 V modulator supply voltage.

Next TX signals are converted to single ended by discrete baluns. EGSM and DCS1800 branches are combined with diplexer.

The final amplification is realized with dual–band power amplifier. It has one 50 ohm input and two 50 ohm outputs. PA is able to produce over 3 W (4.5 dBm

input level) in EGSM band and over 1.5 W (6 dBm input level) in DCS1800 band into 50 ohm output .

Power control circuitry consists of discrete power detector (common for EGSM and DCS1800) and error amplifier in HAGAR. There is a directional coupler connected between PA output and antenna switch. It is a dualband type and has input and outputs for both systems. This signal is rectified in a schottky–diode and it produces a pulsed DC–signal after filtering.

Power control loop in HAGAR has two outputs, one for each band.

AGC strategy

AGC–amplifier is used to maintain the output level of the receiver in a certain range. AGC has to be set before each received burst. Receiver is switched on roughly 280 us before the burst begins, DSP measures the received signal level and adjusts the AGC–amplifiers via serial bus from MADLinda.

AFC function

AFC is used to lock the transceiver's clock to frequency of the base station. AFC–voltage is generated in COBBA with 11 bit D/A–converter. Settling time requirement for the RC–network comes from signalling, how often PSW (pure sine wave) slots occur. They are repeated every 10 frames, meaning that there is PSW in every 46 ms. AFC tracks the base station frequency continously, so transceiver has a stable frequency, because there are no rapid changes in VCTCXO–output (changes due to temperature and other effects are relatively slow).

Antenna switch

SWITCH (SW_1, SW_2)

Table 20. Electrical specification

Parameter	Min.	Typ.	Max.	Unit
Terminating impedance		50		ohm
VSWR			1.8	
Permissible input power		3.0 PEAK		W
Control voltage : HI	2.4	2,7	2.8	V
LO	0		0.2	V
Control current (TX–mode)			10	mA
(RX–mode)			10	uA

TX–FILTERS

Table 21. TX_1 to ANT Electrical specifications

Parameter	Min.	Typ.	Max.	Unit
Passband		880 – 915		MHz
Terminating impedance		50		ohm
VSWR, TX_1 and ANT			1.8	
Permissible input power		3.0 PEAK		W

Table 22. TX_2 to ANT Electrical specifications

Parameter	Min.	Typ.	Max.	Unit
Passband		1710 – 1785		MHz
Terminating impedance		50		ohm
VSWR, TX_2 and ANT 1710...1785 MHz			1.8	
Permissible input power		2.0 PEAK		W

RX–FILTERS

Table 23. ANT to RX_1 Electrical specifications

Parameter	Min.	Typ.	Max.	Unit
Passband	925		960	MHz
Terminating impedance		50		ohm
VSWR, ANT and RX_1			2.0	
Permissible input power		11		dBm

Table 24. ANT to RX_2 Electrical specifications

Parameter	Min.	Typ.	Max.	Unit
Passband	1805		1880	MHz
Terminating impedance		50		ohm
VSWR, RX_2 and ANT (1805...1880 MHz)			2.0	
Permissible input power		11		dBm

Receiver blocks

RX EGSM900/DCS1800 DUALBAND SAW FILTER

Unbalanced inputs and outputs

Table 25. Electrical specifications

Parameter	Min.	Typ.	Max.	Unit
Filter 1 (from input 1 to output 1)				
Passband		925 – 960		MHz
Insertion loss		2.6	3.5	dB
Terminating impedance		50		ohm
VSWR		19	2.3	
Maximum drive level			10	dBm
Filter 2 (from input 2 to output 2)				
Passband		1805 – 1880		MHz
Insertion loss		2.6	3.8	dB
Terminating impedance		50		ohm
VSWR		2.0	2.3	
Maximum drive level			10	dBm

EGSM Pre–amplifier (LNA)

Table 26. EGSM Pre–amplifier specifications

Parameter	Min.	Typ.	Max.	Unit/Notes
Frequency band		925 – 960		MHz
Supply voltage	2.67		2.85	V
Current consumption		6.5		mA
Gain	17.9	18.1	18.3	dB
Input VSWR (Zo=50 ohms)	1.9		2.2	
Output VSWR (Zo=50 ohms)	1.9		2.0	
Gain step		29		dB

DCS1800 Pre–amplifier (LNA)

Table 27. DCS1800 Pre–amplifier specifications

Parameter	Min.	Typ.	Max.	Unit/Notes
Frequency band		1805 – 1880		MHz
Supply voltage	2.4		2.85	V
Current consumption		6.5		mA
Input VSWR	1.2		1.6	
Output VSWR	2.9		3.3	
Gain step		32		dB, room temp.

GSM/PCN IC (Hagar), RX part

Table 28. GSM/PCN IC RX part Specification

Parameter	Minimum	Typical	Maximum	Unit / Notes
Supply voltage	2.7	2.78	2.86	V
Current consumption				mA
Input frequency range Lower band input Upper band input		925 – 960 1805 – 1880		 MHz MHz
Voltage Gain	69	73	77	dB
Input impedance		200		Ω / pF
Output frequency range (–3dB)		190kHz		BB signal
LO frequency range	3610		3840	MHz
LO feed through to RF input			–20	dBm
LO/2 feed through to RF input			–50	dBm
LO/4 feed through to RF input			–50	dBm
Maximum output range	1.4			Vpp
Offset of DCN2–amplifier			20	mV

Transmitter blocks

IQ–modulator and TX–AGC in HAGAR IC

Table 29. Total Transmitter Parameters (GSM/PCN)

Parameters	Min	Typ	Max	Units
Supply Voltages (OC–output)	2.7	2.78	2.86	Volts
Output Frequency GSM	880		915	MHz
Output Frequency PCN	1710		1785	MHz
Linear Output Power, 100 ohm load, GSM *	4			dBm
Linear Output Power, 100 ohm load, PCN *	3			dBm

Table 30. I/Q Parameters

Parameters	Min	Typ	Max	Units
I/Q Minimum Input frequency (depends on external capacitor if AC–coupled)	0			Hz
I/Q Maximum Input frequency	300			kHz
I/Q Input Level (balanced input)		1		Vpp
I/Q Baseband Input Resistance (balanced)	10			MΩ
I/Q Baseband Input Capacitance (balanced)		20		pF
I/Q Input Common–mode Voltage	1	1.2	1.25	V

EGSM TX saw filter

Table 31. Electrical specifiations Tamb = –10 ... +80 deg. C

Parameter	Min.	Typ.	Max.	Unit
Passband		880 – 915		MHz
Insertion loss		2.3	3.5	dB
Attenuation DC...800 MHz	17	19		dB
Attenuation 800...860 MHz	15	25		dB
Attenuation 935...960 MHz	20	25		dB
Attenuation 960...1850 MHz	20	25		dB
Attenuation 1850...6000 MHz	7	12		dB
Terminating impedance input		50		ohm
Terminating impedance output		50		ohm
VSWR		2.0	2.2	
Maximum drive level			+23	dBm

Diplexer

Table 32. Electrical specifiations

Parameter	Min.	Typ.	Max.	Unit
Frequency range GSM input	880		915	MHz
Frequency range PCN input	1750		1785	
Input impedance		50		ohm
Output impedance		50		ohm
Input power			5	dBm
VSWR all ports			1.65	

TX–buffer and 3dB attenuator

Table 33. Electrical specifiations

Parameter	Min.	Typ.	Max.	Unit
Frequency range	880		1785	MHz
Input impedance		50		ohm
Output impedance		50		ohm
Input power GSM (880...915 MHz)		0		dBm
Input power PCN (1710...1785 MHz)		2		dBm
Output power GSM		5.6		dBm
Output power PCN		3.3		dBm
Supply voltage		2.8		V
Current consumption		26		mA

Dual–band power amplifier

Table 34. Maximum Ratings (GSM/PCN)

Parameter	Symbol	Rating	Unit
DC Input Voltage	Vcc	8.0 5.1	V V
Input Power	Pin	+6.0	dBm

Table 35. Max. ratings, GSM

Parameter	Symbol	Min	Typ	Max	Unit
Operating freq. range:		880		915	MHz
Supply voltage	Vcc	3.1	3.5	5.1	V
Current of power control input	Ipctrl			3	mA
Input impedance	Zin		50		ohm
Output impedance	Zout		50		ohm
Input power	Pin		3		dBm
Output power	Pout(1)	35	36		dBm
Output power	Pout(2)	33.6			dBm
Control voltage range	Vpctrl	0.2		2.2	dB
Input VSWR				3.5	

Table 36. Max. ratings, PCN

Parameter	Symbol	Min	Typ	Max	Unit
Operating freq. range:		1710		1785	MHz
Supply voltage	Vcc	3.1	3.5	4.8	V
Current of power control input	Ipctrl			3	mA

Table 36. Max. ratings, PCN (continued)

Parameter	Symbol	Min	Typ	Max	Unit
Input impedance	Zin		50		ohm
Output impedance	Zout		50		ohm
Input power	Pin	4.5			dBm
Output power	Pout(1)	33			dBm
Output power	Pout(2)	31.2			dBm
Control voltage range	Vpctrl	0.2		2.2	dB
Isolation			–42	–37	dBm
Input VSWR			1.5	3	

Directional coupler

Table 37. Directional coupler specifications

Parameter	Min.	Typ.	Max.	Unit/Notes
Frequency range, EGSM900	880		915	MHz
Frequency range, DCS1800	1710		1785	MHz
Insertion loss, EGSM900			0.45	dB
Insertion loss, DCS1800			0.45	dB
Impedance level of the main line		50		ohm
VSWR on main line			1.5	

Power detector

Table 38. Power detector specifications

Parameter	Min.	Typ.	Max.	Unit/Notes
Supply voltage	2.7	2.8	2.85	V
Supply current			2.0	mA
Output voltage	0.1		2.2	V
Load resistance	10			kohm

Synthesizer blocks

VCTCXO, reference oscillator

The VCTCXO is the reference oscillator for the SHF synthesizer. It also generates reference clock signal for the digital parts in the system blocks. The oscillation frequency can be adjusted using the AFC control voltage.

Table 39. Electrical specifications, VCTCXO

Parameter	Min.	Typ.	Max	Unit/.Notes
Supply voltage, Vcc	2.60	2.70	2.80	V
Current consumption, Icc			1.5	mA
Operating temperature range	–30		+80	deg. C

Table 39. Electrical specifications, VCTCXO (continued)

Parameter	Min.	Typ.	Max	Unit/.Notes
Nominal frequency		26		MHz
Duty Cycle	40		60	% , (T+) / (Ttotal)
Start up time output level within 90% and output frequency limits +/–0.05ppm from the final value			5	ms

SHF PLL in HAGAR

Table 40. PLL parameters

Parameters	Min	Typ	Max	Units
Input frequency range	1700		4100	MHz
Input signal level (differential)	400			mVpp
Reference input freq		26	30	MHz
Reference input level	500			mVpp

VCO module

Table 41. Electrical specifications, Zo=50 ohm

Parameter	Conditions	Rating	Unit/ Notes
Supply voltage, Vcc		2.7 +/– 0.1	V
Supply current, Icc	Vcc = 2.8 V, Vc = 2.25 V	< 20	mA
Control voltage, Vc	Vcc = 2.55...2.85 V	0.8... 3.7	V
Output power level	Vcc = 2.5 V f = 3420...3840 MHz	>–3 min.	dBm
Output impedance and VSWR	f = 3420...3840 MHz	50 ohms,VSWR < 2	

Connections

Antenna

One common antenna resonating on both bands is used. The antenna is located in the cover part. The RF connection between the KL8 module and the antenna is a coaxial cable.

RF connector and antenna switch

There are two antenna connectors in KL8 module. One is the connector for external (car kit) antenna and it has an integrated mechanical switch function. This connector is integrated with the system connector. The other connector is used for connecting the coaxial cable which leads to the communicator's own antenna.

Table 42. External antenna connector and switch

Parameter	Min.	Typ.	Max.	Unit/Notes
Operating frequency range	880		1880	MHz
Insertion loss in GSM band			0.2	dB
Insertion loss in DCS band			0.4	dB
Isolation in GSM band	14			dB
Isolation in DCS band	12			dB
Nominal impedance		50		ohm
VSWR, GSM band			1.3	
VSWR, DCS band			1.5	

Table 43. Internal antenna connector

Parameter	Min.	Typ.	Max.	Unit/Notes
Operating frequency range	880		1880	MHz
Insertion loss in GSM band			0.2	dB
Insertion loss in DCS band			0.4	dB
Nominal impedance		50		ohm
VSWR			1.5	

RF–System interface

The System block resides on the same PWB with the RF block yet there is no physical connector between them. The electrical interface to the System block is described below.

Table 44. AC and DC Characteristics of signals between RF and System blocks

Signal name	From	To	Parameter	Mini-mum	Typi-cal	Maxi-mum	Unit	Function
VBATT	Battery	PA	Voltage	3.1	3.7	4.8	V	PA supply voltage
			Current			3500	mA	
VREF_2	CCONT VREF	HAGAR	Voltage	1.478	1.5	1.523	V	Reference voltage for HAGAR
			Current			150	uA	
VXO	CCONT VR1	VCTCXO	Voltage	2.7	2.8	2.85	V	Supply voltage for VCTCXO, Hagar digital parts.
			Current		1.5		mA	
VSYN_1	CCONT VR4	Vdd_bb, LNA's	Voltage	2.7	2.8	2.85	V	Supply voltage for LNA's and Vdd_bb
			Current			80	mA	
VSYN_2	CCONT VR3	HAGAR,	Voltage	2.7	2.8	2.85	V	Supply voltage for dividers, LO buffers, prescaler, VCO
			Current			50	mA	
VCP	CCONT V5V	HAGAR	Voltage	4.8	5.0	5.2	V	Supply voltage for PLL charge pumps
			Current			30	mA	
VRX	CCONT VR2	HAGAR,	Voltage	2.7	2.8	2.85	V	Supply voltage for LNA2+mixer+DTOS
			Current			80	mA	
VTX	CCONT VR5, VR7	HAGAR	Voltage	2.7	2.8	2.85	V	Supply voltage for TX modulator, VCO
			Current			80	mA	
RESET	MADLin-da	HAGAR	Logic high "1"	2.0		2.85	V	HAGAR reset, active LOW
			Logic low "0"	0		0.5	V	
			Current			tbd.	uA	
			Load capacitance			tbd.	pF	
SENA1	MADLin-da	HAGAR	Logic high "1"	2.0		2.85	V	HAGAR synthesizer interface enable
			Logic low "0"	0		0.5	V	
			Current			tbd.	uA	
			Load capacitance			tbd.	pF	
SDATA	MADLin-da	HAGAR	Logic high "1"	2.0		2.85	V	HAGAR synthesizer interface control data
			Logic low "0"	0		0.5	V	
			Load impedance	tbd.			kohm	
			Load capacitance			tbd.	pF	
			Data rate		3.25		Mbit/s	
SCLK	MADLin-da	HAGAR	Logic high "1"	2.0		2.85	V	HAGAR synthesizer interface clock
			Logic low "0"	0		0.5	V	
			Load impedance	tbd.			kohm	
			Load capacitance			tbd.	pF	
			Clock rate		3.25		MHz	

Table 44. AC and DC Characteristics of signals between RF and System blocks (continued)

Signal name	From	To	Parameter	Minimum	Typical	Maximum	Unit	Function
TXP	MADLinda	HAGAR	Logic high ”1”	2.0		2.85	V	Transmitter power control enable
			Logic low ”0”	0		0.5	V	
			Load Resistance	10		220	kohm	
			Load Capacitance			20	pF	
AFC	COBBA	VCTCXO	Voltage	0.046		2.254	V	Automatic frequency control signal for VCTCXO
			Resolution	11			bits	
			Load resistance (dynamic)	10			kohm	
			Load resistance (static)	1			Mohm	
			Noise voltage			500	uVrms	10...10000Hz
			Settling time			0.5	ms	
RFC	VCTCXO	MADLinda	Frequency		13/26		MHz	High stability clock signal for the logic circuits in the system block
			Signal amplitude	0.5	1.0	2.0	Vpp	
			Load resistance	10			kohm	
			Load capacitance	10	12	14	pF	
RXIP	HAGAR	COBBA	Output level		300	1400	mVpp	Single ended in–phase RX signal to baseband
			Source impedance			10	kohm	
			Load resistance		1		Mohm	
			Load capacitance		8		pF	
RXQP	HAGAR	COBBA	Output level		300	1400	mVpp	Single ended quadrature RX signal to baseband
			Source impedance			10	kohm	
			Load resistance		1		Mohm	
			Load capacitance		8		pF	
RXREF	COBBA	HAGAR	Voltage	1.15	1.2	1.25	V	Reference voltage for RX baseband signals
			Source impedance			200	ohm	
			Current			50	uA	

Table 44. AC and DC Characteristics of signals between RF and System blocks (continued)

Signal name	From	To	Parameter	Minimum	Typical	Maximum	Unit	Function
TXIP/ TXIN	COBBA	HAGAR	Differential voltage swing (x0.75)	1.226	1.32	1.416	Vpp	Differential in–phase TX baseband signal for the TX I/Q modulator. **Note:** swing multiplier may change later
			DC level	1.165	1.2	1.235	V	
			Differential offset voltage (corrected)			+/–2.0	mV	
			Diff. offset voltage temp. dependence			+/–5.0	mV	
			Source impedance			500	ohm	
			Load resistance	40			kohm	
			Load capacitance			10	pF	
			Resolution	8			bits	
TXQP/ TXQN	COBBA	HAGAR	Differential voltage swing (x0.75)	1.226	1.32	1.416	Vpp	Differential quadrature TX baseband signal for the TX I/Q modulator. **Note:** swing multiplier 0.75 may change later
			DC level	1.165	1.2	1.235	V	
			Differential offset voltage (corrected)			+/–2.0	mV	
			Diff. offset voltage temp. dependence			+/–5.0	mV	
			Source impedance			500	ohm	
			Load resistance	40			kohm	
			Load capacitance			10	pF	
			Resolution	8			bits	
TXC	COBBA	HAGAR	Voltage Min	0.12		0.18	V	Transmitter power control voltage
			Voltage Max	2.27		2.33	V	
			Vout temperature dependence			+/–50	ppm/ °C	
			Source impedance active state			200	ohm	
			Input resistance	10			kohm	
			Input capacitance			10	pF	
			Settling time			10	us	
			Noise level			500	uVrms	0...200 kHz
			Resolution	10			bits	

Timings

Transmit power Timing

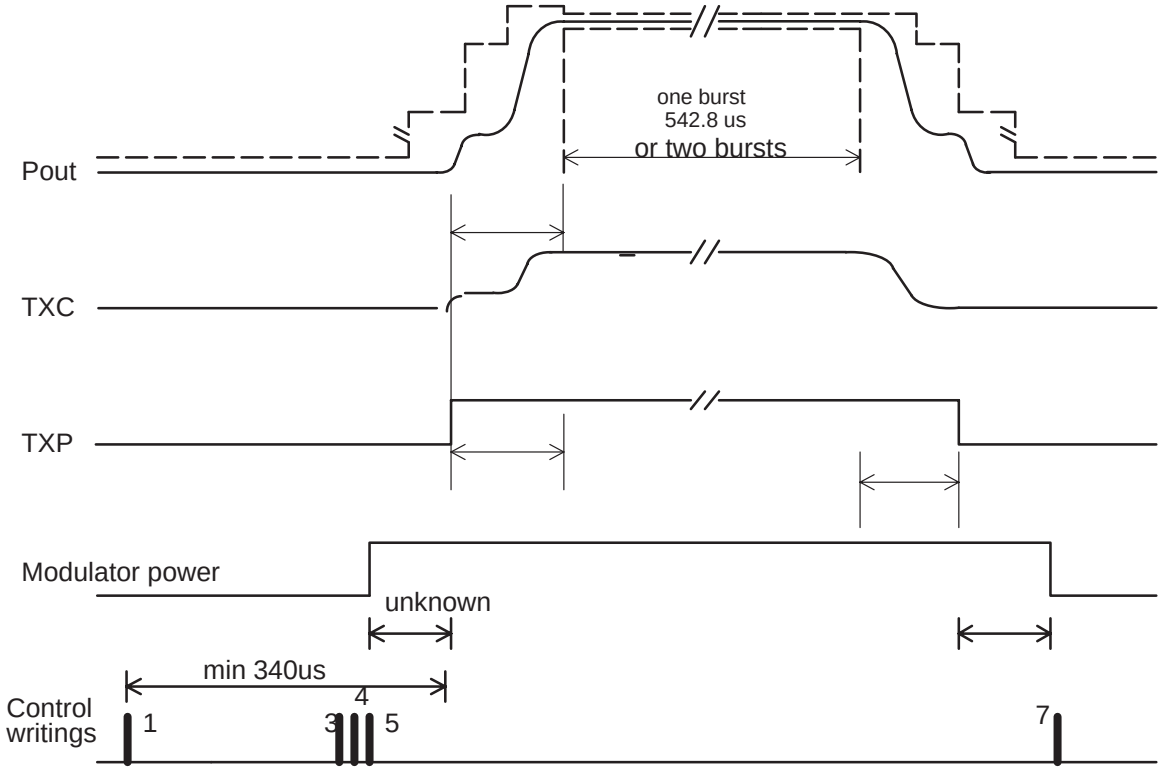

Figure 14. Transmitter control timing diagram for all kind of TX bursts

Synthesizer clocking

Synthesizers are controlled via serial control bus, which consists of SDATA, SCLK and SENA1 signals. These lines form a synchronous data transfer line. SDATA is for the data bits, SCLK is 3.25 MHz clock and SENA1 is latch enable, which stores the data into counters or registers. The signal SENA1 is latch enable also for HAGAR control register, which is used for programming some internal functions in HAGAR, e.g. in band changing. In this case SCLK and SDATA are used the same way as in PLL programming.

Table 45. Internal antenna connector

Parameter	Min.	Min.	Typ.	Max.	Unit/Notes
Operating frequency range	880	880		1880	MHz
Insertion loss in GSM band				0.2	dB
Insertion loss in DCS band				0.4	dB

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