

PAMS Technical Documentation

RAE-2 Series Transceiver

Chapter 1

GENERAL INFORMATION

CHAPTER 1 – GENERAL INFORMATION

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Introduction

RAE-2N is the 2nd generation communicator for GSM 900 network. Communicator extends the basic digital cellular phone with in-built data capabilities and applications.

RAE -2 is a phase 2, class4 transceiver with 2W peak TX power.

The device has two user interfaces. The conventional phone interface on the front cover. By opening the device the user can access the graphical user interface which can utilize the full communicator functionality.



Technical Summary

The Communicator is divided into two main domains: phone and personal digital assistant (PDA). Phone manages speech and data connections to GSM network. It also handles audio input and output. PDA runs all the applications (e.g. calendar, contact database etc...) and utilizes the data connections made by the phone.

The phone is based on DCT3 technology and CUI style user interface software. PDA uses AMD's 486 CPU and GEOS operating system.

Battery technology is Li-ion.

The product has earpiece for conventional phone use but it also has an internal handsfree speaker.

Connection to the other devices can be handled with 115kbps serial cable or 115kbps IR. Product is IrDA compatible.

The phone display is graphical, transfective FSTN LCD display. Display resolution is 84x48 pixels. The PDA display is graphical, transfective FSTN LCD display. Display resolution is 640x200 pixels and dot pitch is 0.17mm. Contrast is good enough to show 16 gray scales.

Both LCD displays are backlit with EL-panel.

In addition to the fixed memory the product can use memory extension module, MMC, to expand the user file system area. The MMC supports hot insertion.

NOTE: Due to the infrared data link the RAE-2 is officially specified as :

CLASS 1 LASER PRODUCT.

See IEC 60825-1 specification 825-1; Labelling, 5.1 General 5.2 Class 1.

Product Selection

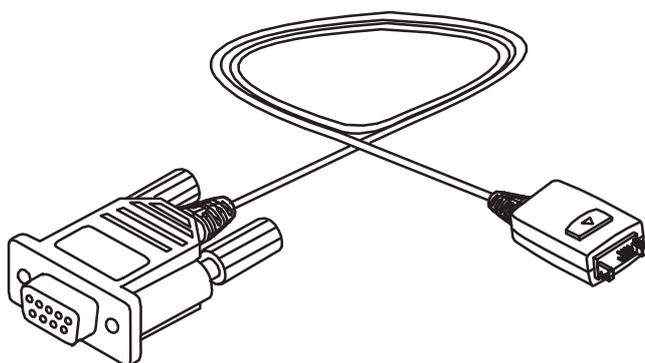
The product has only one design, however each user interface language version has its own product code. Some countries have e.g. English communicator but manuals in the local language.

Name of Sales Package	Sales Package Code	Notes
Nokia RAE-2NA	0069108	English
Nokia RAE-2NC	0069109	French
Nokia RAE-2NB	0069110	German
Nokia RAE-2NA Benelux	0069111	Benelux
Nokia RAE-2NS	0069112	Swedish
Nokia RAE-2NN	0069113	Norwegian
Nokia RAE-2NP	0069114	Danish
Nokia RAE-2NM	0069115	Finnish
Nokia RAE-2NR	0069116	Italian
Nokia RAE-2NA S/AFRICA	0069126	South Africa
Nokia RAE-2NA Poland	0069127	Polish
Nokia RAE-2NA Baltic	0069128	Estonian, Latvian, Lithuanian
Nokia RAE-2NF	0069129	Spanish
Nokia RAE-2NG	0069130	Portuguese
Nokia RAE-2NA EURO1	0069131	Hungarian, Turkish, Czech, Romanian
Nokia RAE-2NA EURO2	0069132	Greek, Romanian, Slovenian
Nokia RAE-2NA Russian	0069133	Russian

Units and Accessories

Name of unit or accessory	Type code	Material code	Notes
Battery	BLN-3	0670226	1140 mAh, Li-Ion
Performance Travel Charger	ACP-9E	0675149	Fore EURO version
Mobile Charger	LCH-9	0271056	
Advanced Desktop Stand	DCH-7	0271365	
RS-232 Adapter Cable	DLR-2	0730132	
Headset	HDC-8	0271368	
Advanced HF Car Kit	CARK-99	0085155	
Privacy Handset	HSU-1	0270830	
Upgrade HF Car Kit	CARK-102		
Memory Card	DTS-4	0271393	Removable memory card MMC
Carrying Case	CBR-4	0271410	

Accessories for PC connection



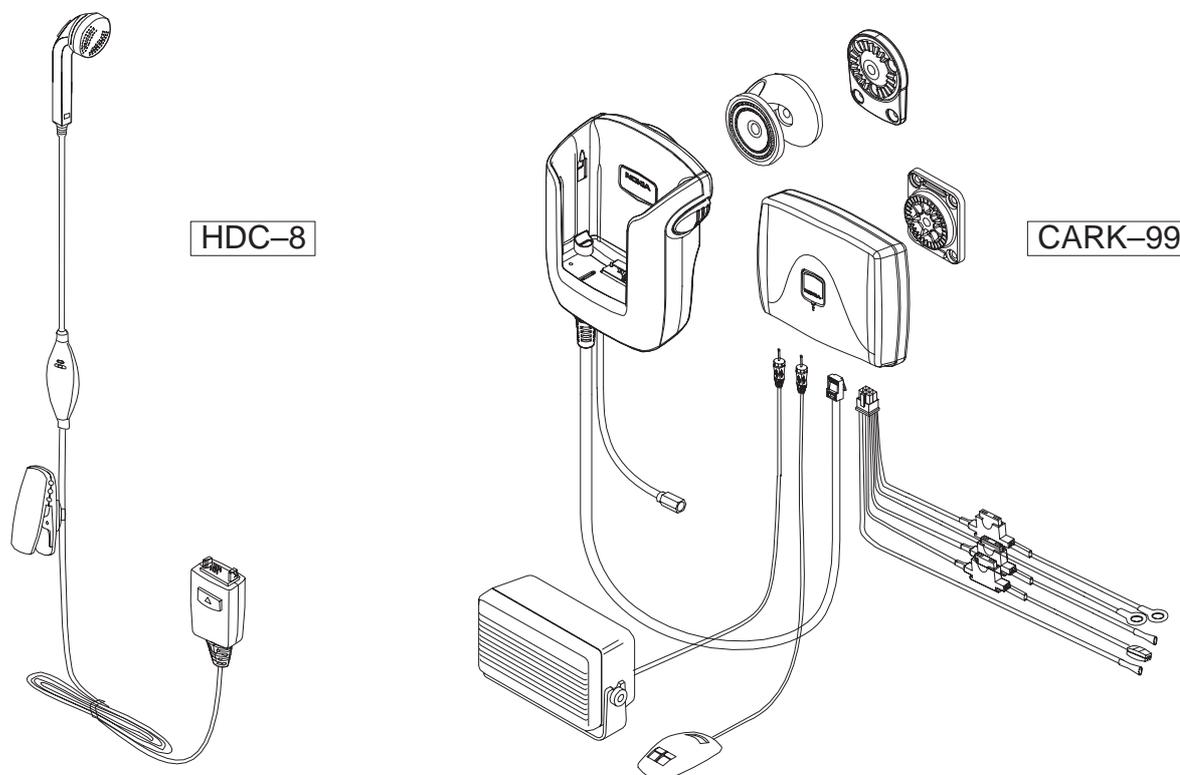
DLR-2



DCH-7

The desktop stand can charge the transceiver and one BLN-3 battery simultaneously. It also provides connectivity to personal computer. The button in the front of the deskstand starts synchronization operation if the deskstand is connected to PC with serial cable (DLR-2) and the connectivity software in PC is activated.

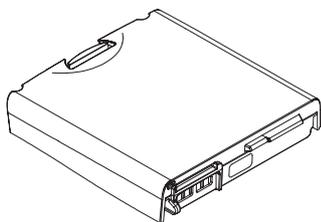
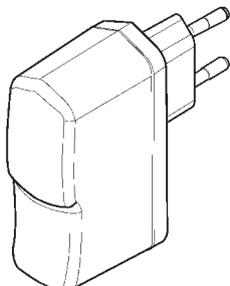
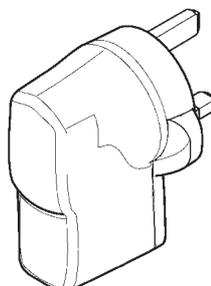
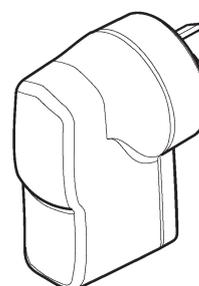
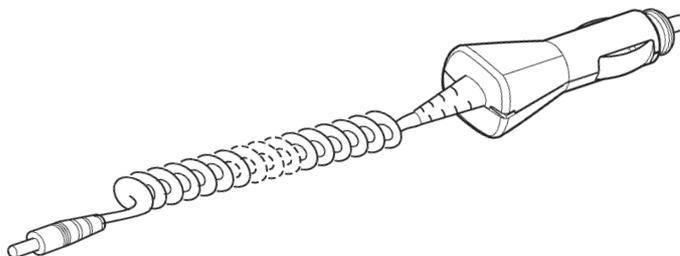
Audio Accessories



Headset differs from DCT3 headset, having a different connector.

The Car kit has a product specific cradle. It is possible to connect DLR-2 PC-connectivity cable to cradle. Privacy handset (HSU-1) is the same as used with DCT3 products .

Battery and Chargers

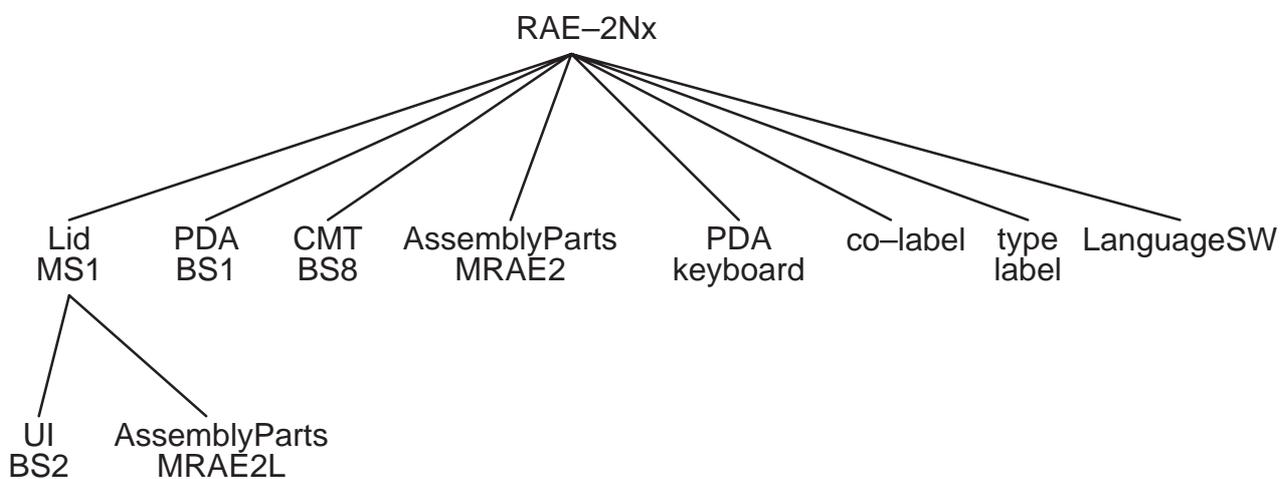
Battery**BLN-3****European charger****ACP-9E****UK charger****ACP-9X****Australian charger****ACP-9A****Travel charger****LCH-9**

Other Accessories

The Memory card DTS-4 provides additional 4MB of user memory into the product. Memory cards complies to the open MMC specification. In the future there will be also larger memory capacities available.

Structure

RAE-2Nx consists of three electrical sub-modules and several mechanical parts. The structure is basically the same for all the language versions. The only parts that are unique to each language version are located on the first hierarchy level of the product structure; namely PDA keyboard, Language software and type label. All other parts and modules are language independent.



List of Modules

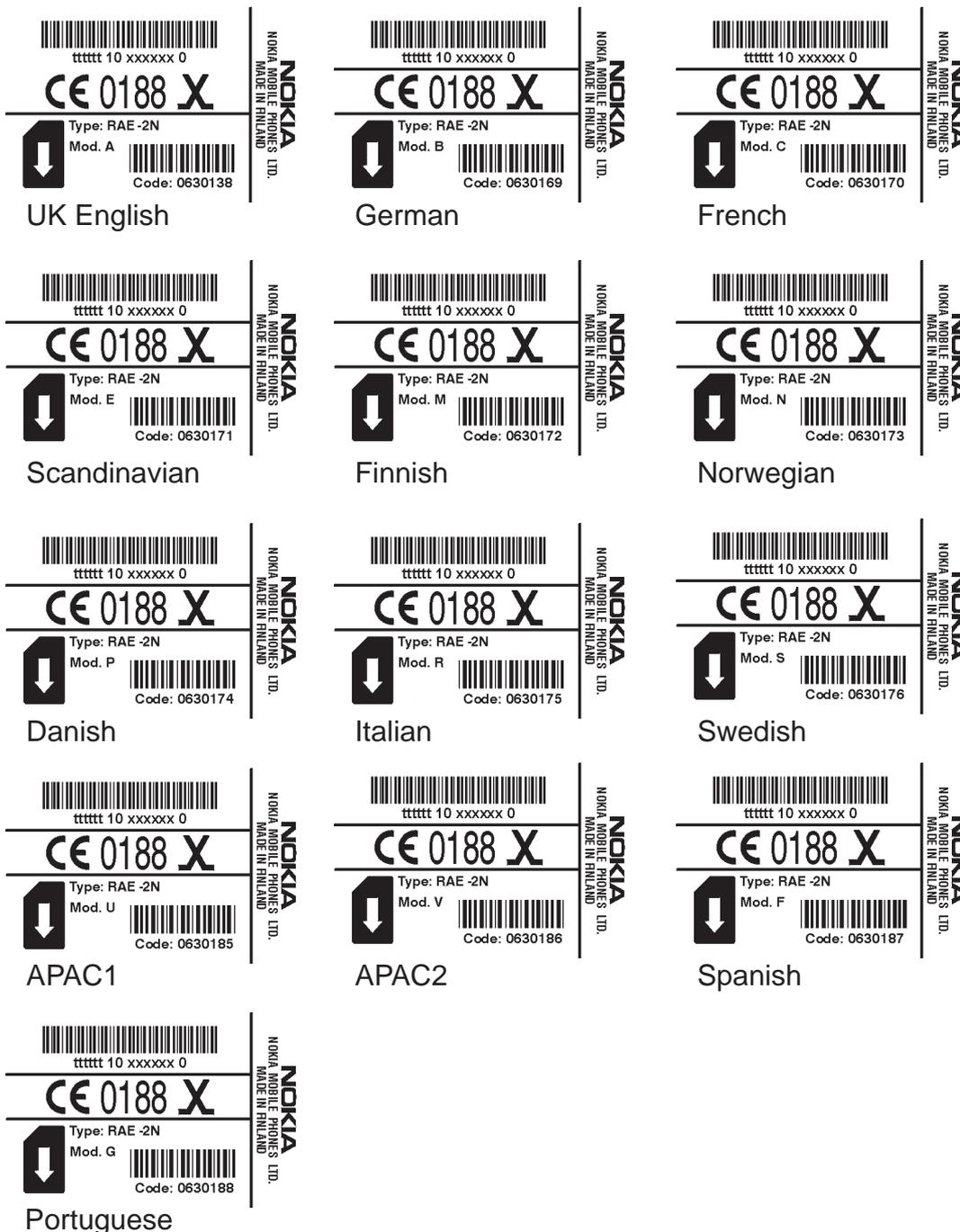
Name of module	Type code	Material code	Notes
MS1		0201224	Lid sub-assembly, contains UI
BS1	BS1	0201096	PDA module, includes CPU and memories
BS8	BS8	0201095	GSM phone module
MRAE2		0261780	Mechanical assembly parts , no language dependent parts
BS2	BS2	0201097	UI module, includes both LCD's
MRAE2L		0261786	Assembly parts for lid sub-assembly

Basic Specifications

Dimensions	56x159x25 mm
Weight	200g (excluding battery)
Battery	BLN-3, Li-Ion, 1030mAh, 3.6V, 49,1g
Standby time	5-7 days
Talk time	3-7h
Transceiver	GSM, class 4
PDA cpu	AMD 486, 33MHz
Fixed user memory	2Mbytes
Fixed application memory	4Mbytes
RAM memory (PDA)	2Mbytes

Type Labels

Each transceiver with unique mechanics or software has its own type label.



APAC1 and APAC2 are products with UK English user interface with software settings meant for APAC. Scandinavian product has Scandinavian keyboard but UK English user interface.

Keymat Variants

The keymat used depends in the language environment.

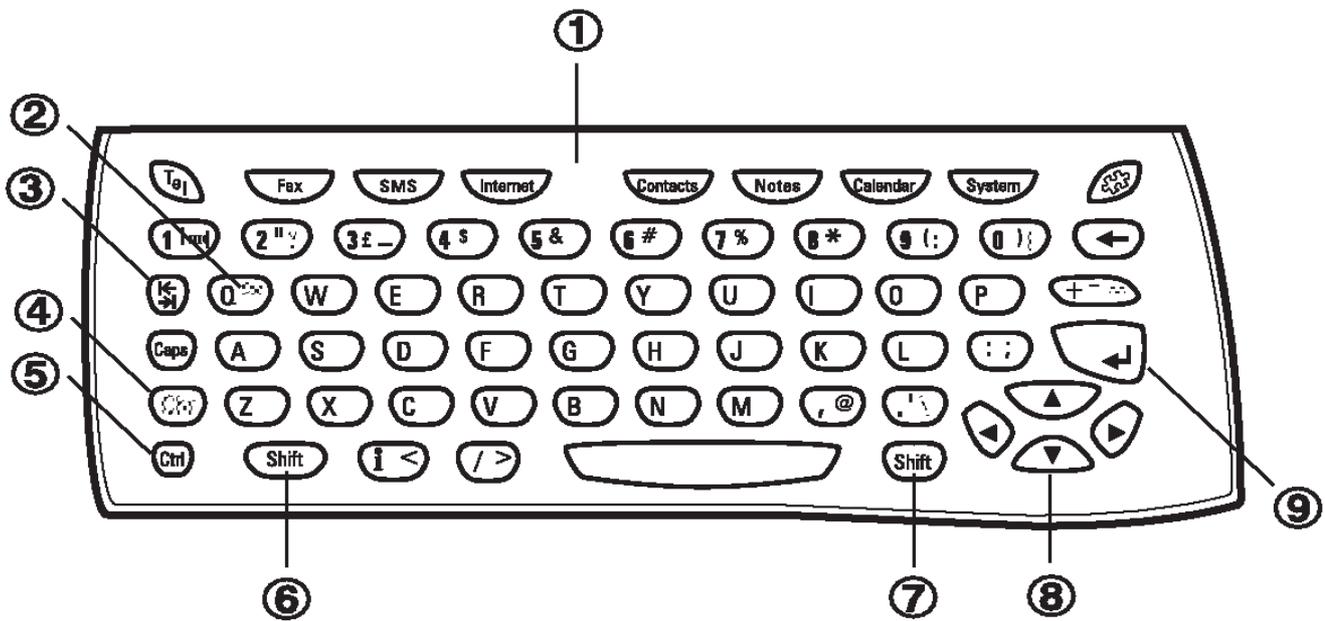


Figure 1. English keymat

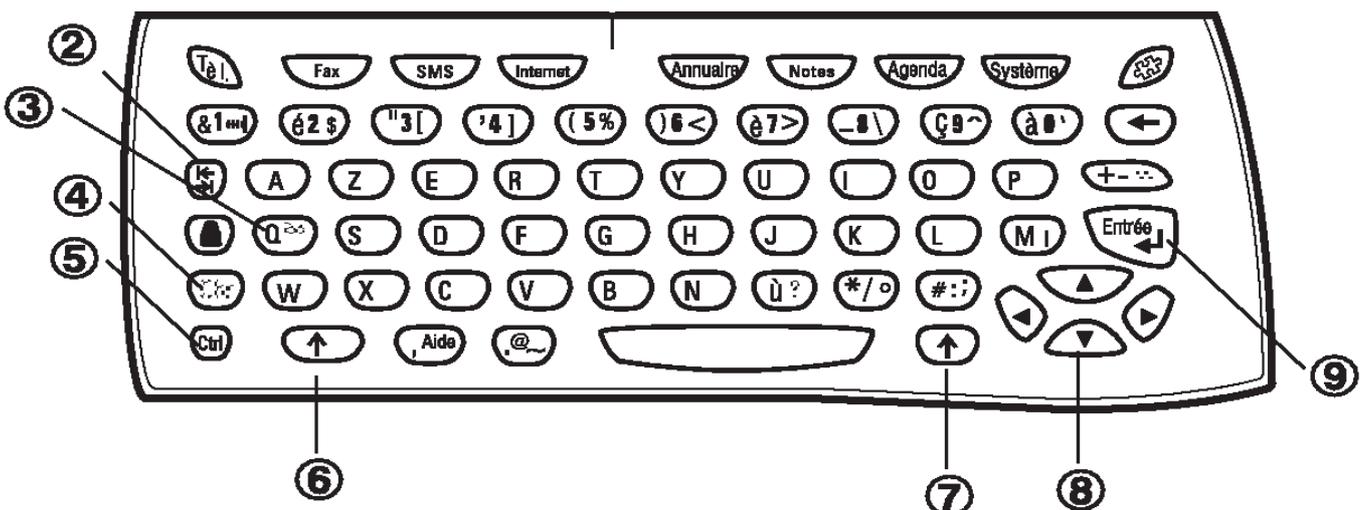


Figure 2. French keymat

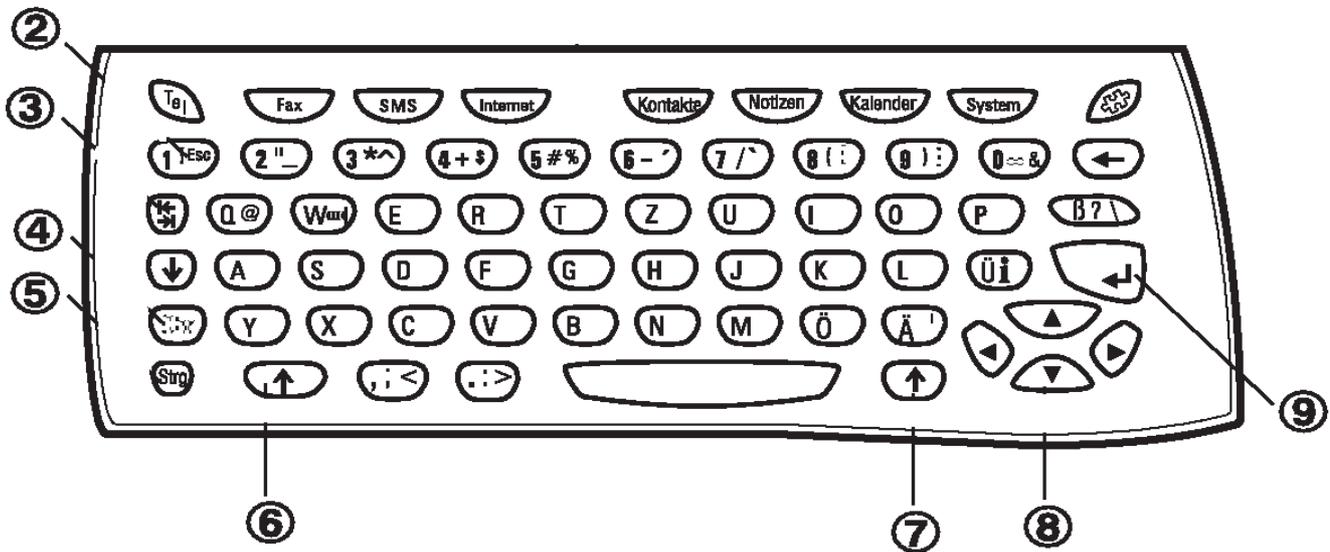


Figure 3. German keymat

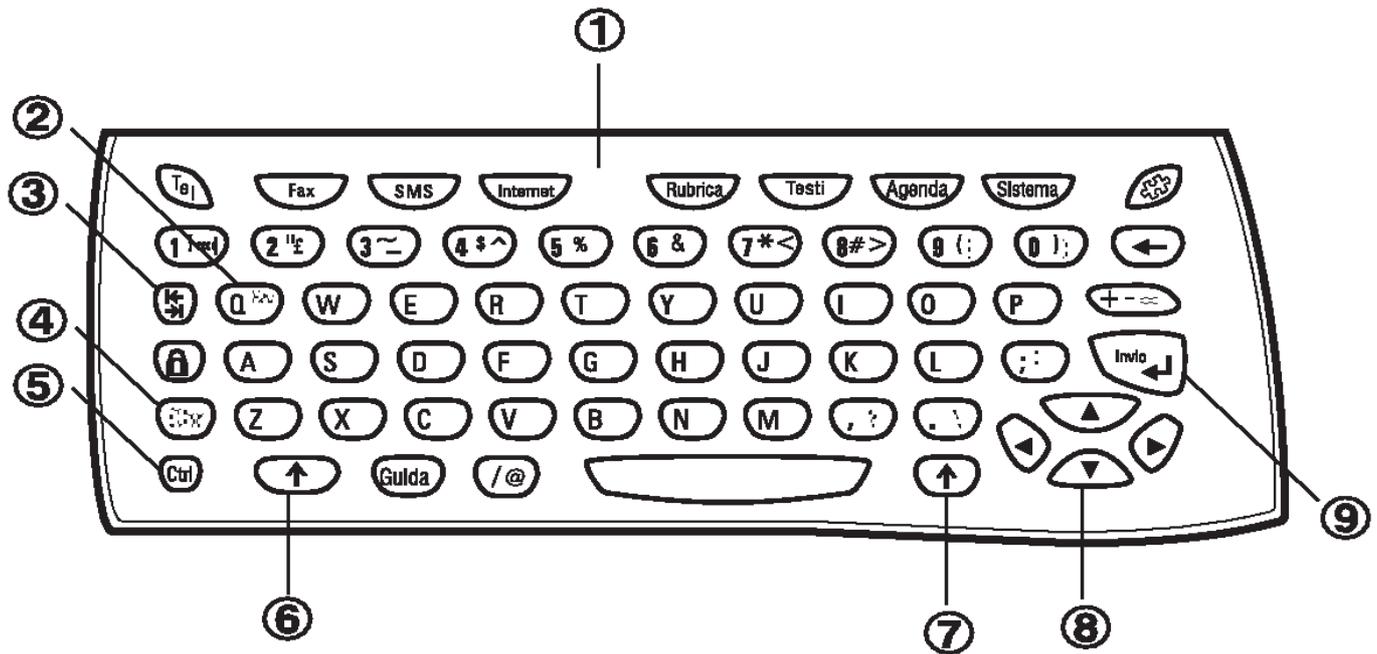


Figure 4. Italian keymat

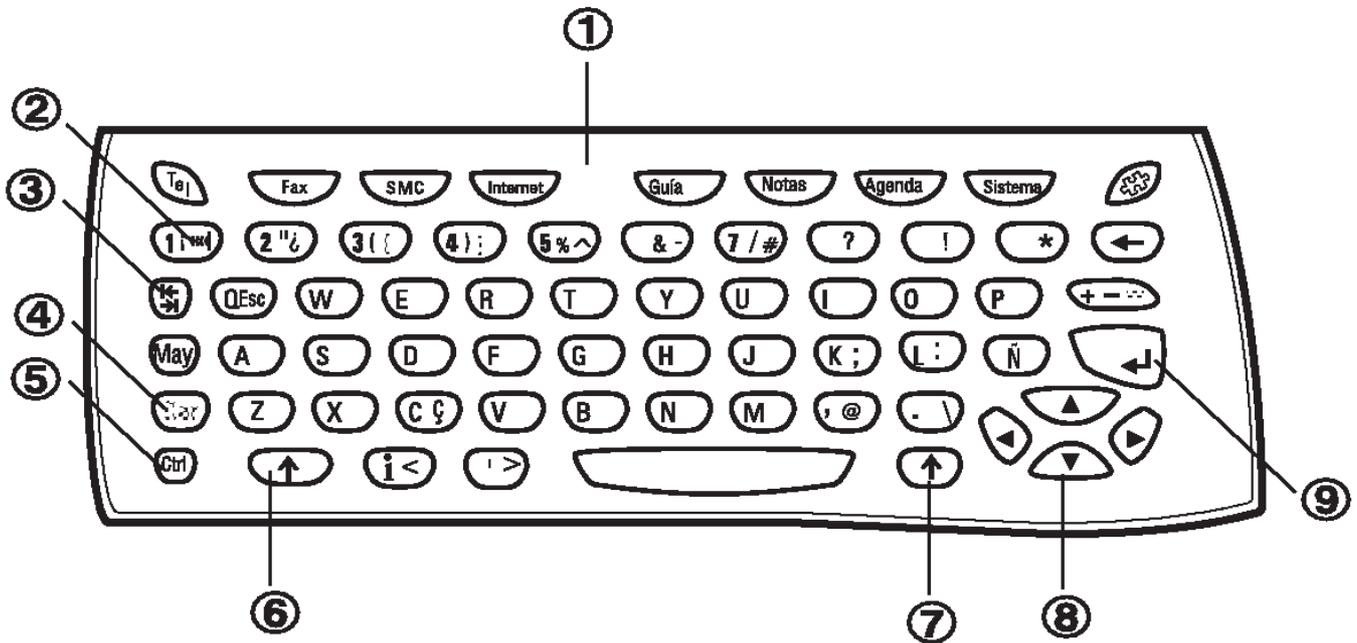


Figure 5. Spanish keymat

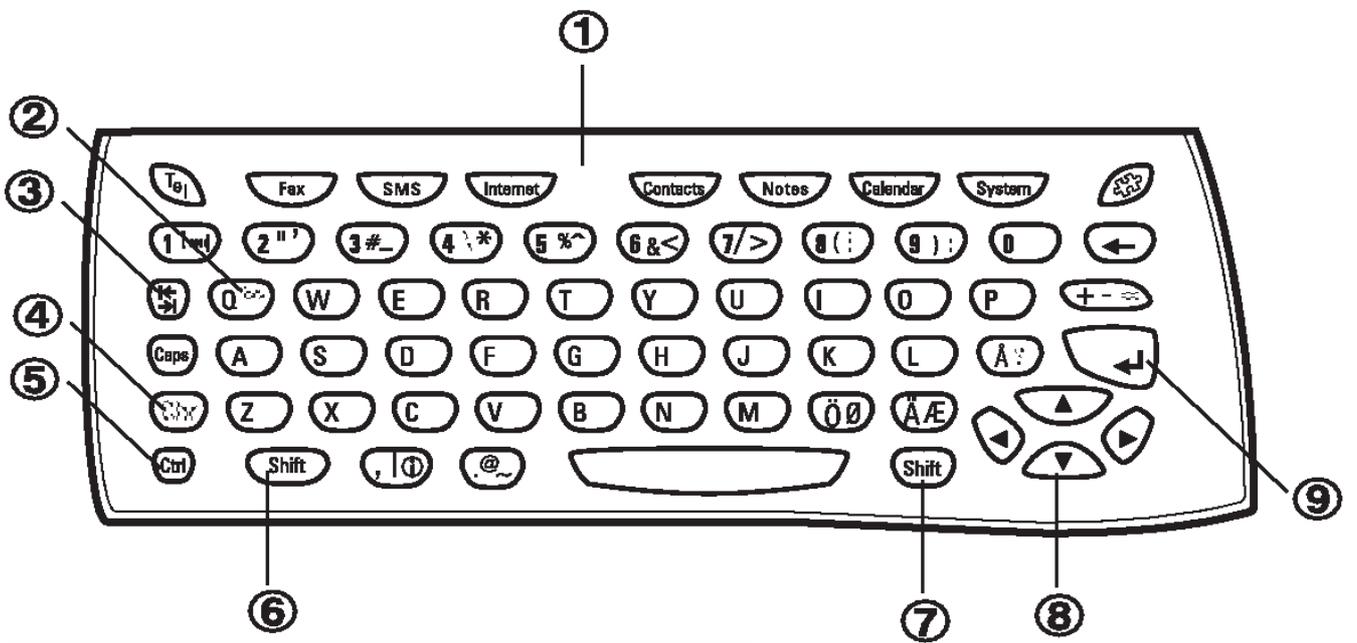


Figure 6. Scandinavian keymat

Technical Specifications

Modes of Operation

The Communicator has several different operating modes depending on the activity of CMT and PDA modules. CMT unit can be switched off, idle or call. PDA can be active, standby, suspended or reset. If the battery voltage is too low PDA is held in reset-mode.

Electrical Specifications

DC Characteristics

DC-supply for the product is BLN-3 Li-Ion battery. Nominal voltage is 3.6V, Capacity is 1030mAh i.e. 3708 mWh.

Nominal system voltage for both PDA and CMT is 2.8V.

Average Current Consumption

PDA mode	CMT mode		
	Off	Idle	Call
Active	90	100	240
Standby	60.5	63	185
Suspended	3.2	5.5	165

Backlight power consumption is 60mA. Handsfree consumes about 80mA.

AC Characteristics

Product contains two EL-panels for CMT and PDA display backlighting.

EL Characteristics, PDA and CMT

Parameter	Minimum	Typical / Nominal	Maximum	Unit
Frequency	60	70	180	Hz
Peak-to-peak voltage	170	175	180	V
RMS voltage	70	72	75	V

Main RF Characteristics

Item	Values
Receive frequency range	935 ... 960 MHz
Transmit frequency range	890 ... 915 MHz
Duplex spacing	45 MHz
Channel spacing	200 kHz
Number of RF channels	124
Power class	4
Number of power levels	15

Transmitter characteristics

Item	Values
Type	Upconversion, nonlinear, FDMA/TDMA
Intermediate frequency (phase modulated)	116 MHz
LO frequency range	1006 ... 1031 MHz
Output power	2 W peak (33 dBm)
Power control range	min. 5 ... 30 dBm
Maximum phase error (RMS/peak)	max 5 deg./20 deg. peak

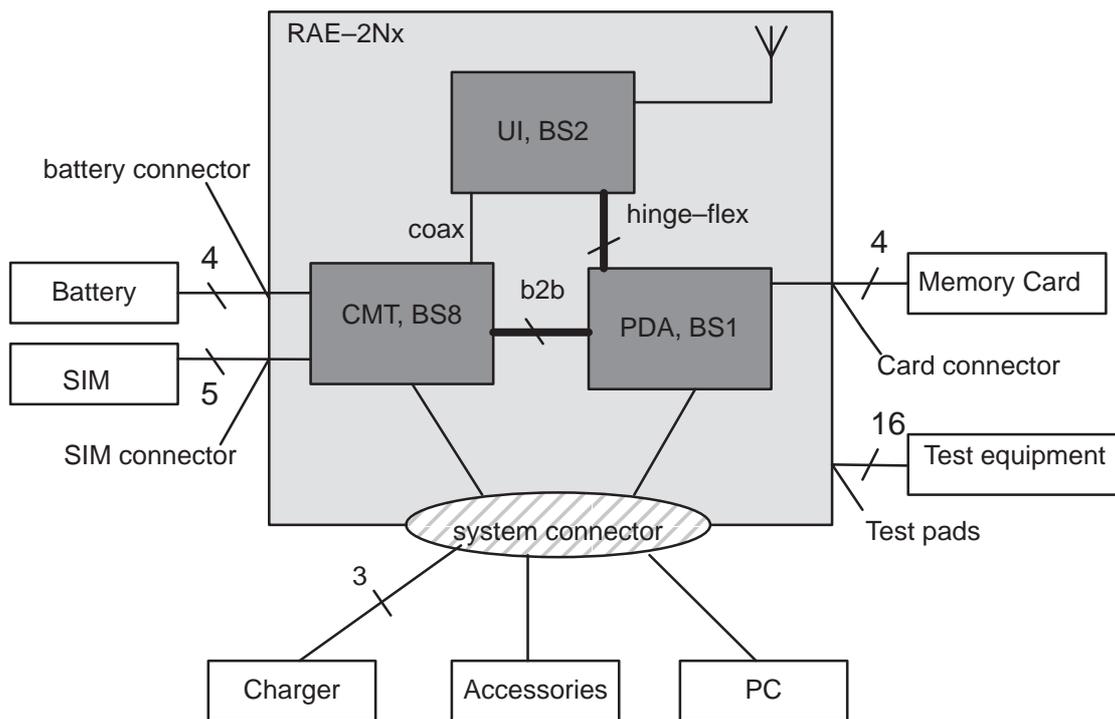
Receiver characteristics

Item	Values
Type	Linear, FDMA/TDMA
IF frequencies	1st 71 MHz, 2nd 13 MHz
LO frequencies	1st LO 1006 ... 1031 MHz, 2nd LO 58 MHz
Typical 1 dB bandwidth	+/- 90 kHz
Sensitivity	min. - 102 dBm , S/N >8 dB
Total typical receiver voltage gain (from antenna to RX ADC)	73 dB
Receiver output level (RF level -95 dBm)	50 mVpp (typical balanced signal level of 13 MHz IF in RF BB interface = input level to RX ADCs)
Typical AGC range	-17 ... +40 dB
Accurate AGC control range	57 dB
Typical AGC step in LNA	-15 dB
Usable input dynamic range	-102 ... -10 dBm
RSSI dynamic range	-110 ... -46 dBm
AGC relative accuracy on channel (accurate range)	+/- 0.8 dB
Compensated gain variation in receiving band	+/- 1.0 dB

Audio characteristics

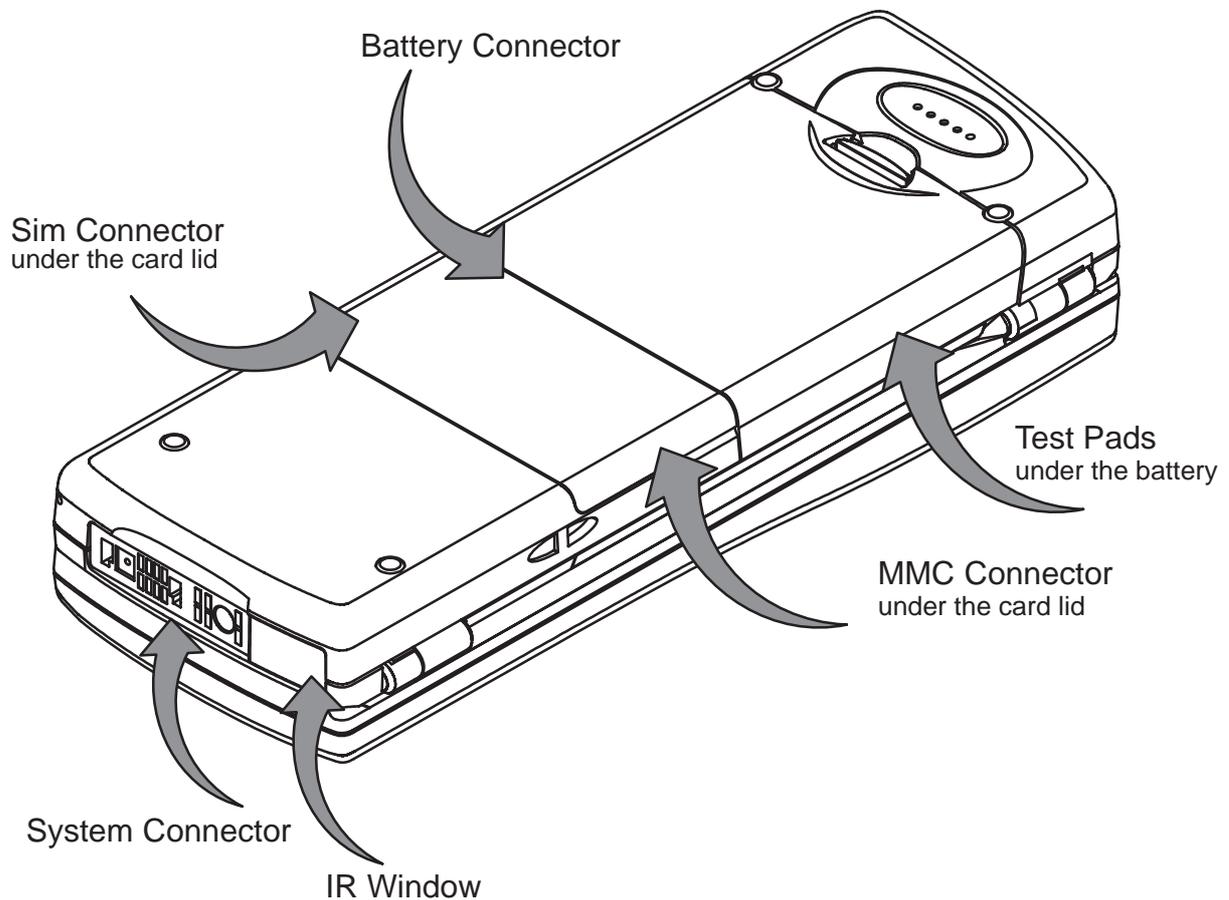
	Minimum	Typical / Nominal	Maximum	Unit / Notes
Output freq. range (earpiece)	300		3400	Hz
Output freq. range (HF speaker)	300		3400	Hz
Mic. input range.	300		3400	Hz
ringing tone SPL			105	dB at 5 cm
HF speaker SPL		65		dB at 50 cm
Sampling rate		8		kHz
Dynamic range (input)		13		bits
Dynamic range (output)		13		bits

Interconnection Diagram



External connections and signals

External Connections:



List of external connectors

Connector Name	Code	Notes	Specifications / Ratings
Battery connector	5469087		
System connector	5469091	includes also DC and RF	
Memory card connector	5469085	removable memory card	
SIM connector	5409089		
Test pads		PCB test pads for production and after sales	

SIM and MMC cards cannot be removed until the BLN-3 battery has been removed.

Battery Connector

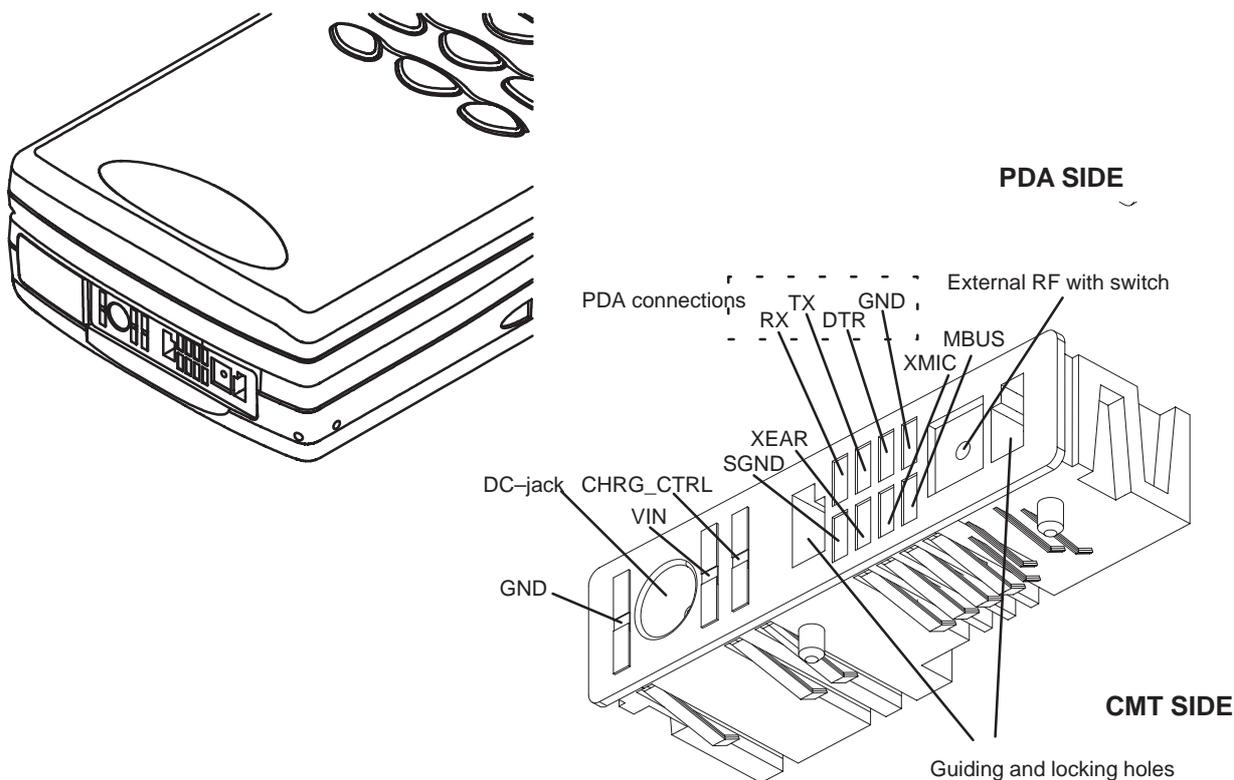
The Battery connector connects BLN-3 battery to the transceiver. The connector indicates the removal of battery about 5ms before the loss of power because pins BSI and BTEMP are shorter than BVOLT and BGND.

Pin	Name	Min	Typ	Max	Unit	Notes
1	VBATT	3.0	3.6	4.1	V	Battery voltage
2	BSI	0		2.85	V	Battery size indication Phone has 180kohm pull up resistor. SIM Card removal detection (Threshold is 2.4V@VBB=2.8V)
		21.8	22	22.2	kohm	BBS-5 Service battery (No cells)
		31.35	33	34.65	kohm	BLN-3 Li-Ion battery (4.1V)
		5			ms	The minimum time from BSI contact disengaged its battery contact to VBATT/ GND disengaged its battery contacts when battery is removed.
3	BTEMP	0		1.4	V	Battery temperature indication Phone has a 100k (+-5%) pull-up resistor, Battery package has a NTC pull-down resistor: 47k+-5%@+25C , B=4050+-3%
4	GND	0		0	V	Battery ground

System Connector

The System connector combines the charger, external RF and system functions. External signals can connect to e.g. car kit, headset and PC.

The system connector is not physically compatible with DCT3 connectors except charger.



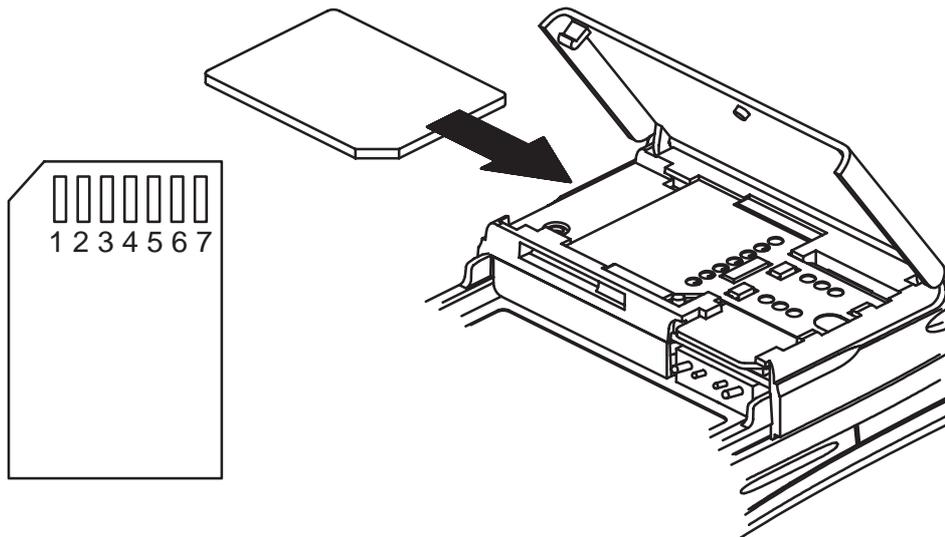
Contact	Line Symbol	CMT Function
1	L_GND	Charger ground
DC-jack side contact (DC-plug ring)	L_GND	Charger ground
DC-jack center pin	VIN	Charger input voltage
DC-jack side contact (DC-plug jacket)	CHRG_CTRL	Charger control output (from CMT)
2	VIN	Charger input voltage
3	CHRG_CTRL	Charger control output (from CMT)

PDA SI

Contact	Line Symbol	CMT Function
4	SGND	Accessory signal ground
5	XEAR	Accessory earphone signal output (from CMT)
6	XMIC	Accessory microphone signal input (to CMT)
7	MBUS	MBUS, bidirectional serial data I/O (DCD in PC use)
8	DCE_RX	serial_RX data. (input)
9	DCE_TX	serial_TX data. (output)
10	DTR	Data Terminal Ready (DTR). No CMT use
11	GND	Ground from BS1 module
12,15	GND	GND contacts for RF ground
13	RF_OUT	RF signal from RF switch to internal antenna
14	RF_IN	RF signal from Duplexer to RF switch

MMC Connector

The MMC connector connects a MMC card to the product. Connector has a small switch that can detect the opening of the card lid.



Pin	I/O	Name	Function	Min	Typ	Max	Unit	Description / Note
1		RSV	Reserved					Reserved for future use
2	I/O	MMC_CMD	MMC Command / Address / Response, Bidirectional	0	0	0.45	VDC	Low, Data to the card
				2.3	2.8	2.85	VDC	High, Data to the card, pulled up with 10kohm resistor to MMC_VSYS in CMT module
						0.34	VDC	Low, Data from the card
				2.1			VDC	High, Data from the card, pulled up with 10kohm resistor to MMC_VSYS in CMT module
					259.3		kHz	Frequency
3		MMC_GND	MMC ground				VDC	
4	I	MMC_VSYS	MMC Power Supply	2.75		2.85	VDC	
5	I	MMC_CLK	MMC Clock	0	0	0.45	VDC	Low
				2.3	2.8	2.85	VDC	High
				0.2592		8.294	MHz	Frequency
6		MMC_GND	MMC Ground					Ground line reserved for MMC use

Pin	I/O	Name	Function	Min	Typ	Max	Unit	Description / Note
7	I/O	MMC_DATA	MMC Bidirectional Data	0	0	0.45	VDC	Low, Data to the card
				2.3	2.8	2.85	VDC	High, Data to the card, pulled up with 10kohm resistor to MMC_VSYS in CMT module
				0	0	0.34	VDC	Low, Data from the card
				2.1			VDC	High, Data from the card, pulled up with 10kohm resistor to MMC_VSYS in CMT module
					8.294		MHz	Frequency

Mechanical Characteristics

Visible product material is ABS+PC except the lens which is clear PMMA. The bottom part of the device has a magnesium chassis.

Unit	Dimensions (mm) (W x H x D)	Weight (g)
Transceiver, RAE-2Nx	56x159x25	202.6
Battery, BLN-3	56x58x12	49.1

User Interface specifications

The product has two separate user interfaces (UI): CMT UI on the front cover and PDA UI which can be accessed by opening the device.

CMT UI conforms to Jack-style defined by NMP. The detailed feature list and UI specifications can be found in PCMS.

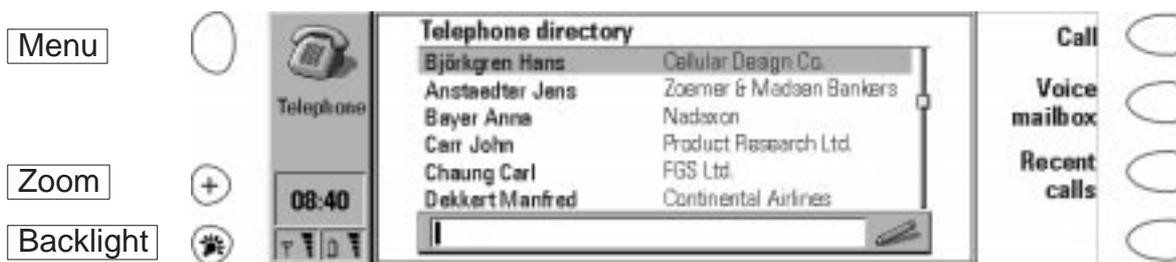
User Interface Features

The RAE-2 has two separate user interfaces (UI): CMT UI on the front cover and PDA UI which can be accessed by opening the device.

Highlights of the CMT interface are:



PDA UI is based on the previous Nokia Communicator product, N9000. The main difference is that leftmost scroll buttons are replaced by Menu, Zoom and Backlight buttons.



Menu-button activates an additional pop-up menu window. The contents of the window depend on the current application. They can be e.g. settings for the telephone application.

Zoom-button toggles the font size of certain views. The zoomable view depends on the current application. The device has three different zoom levels.

Backlight-button activates the backlight for a pre-set period or until the button is pressed again. Backlight makes it possible to use the product in low light conditions.

Temperature and Environmental Conditions

Allowed ambient temperature ranges are listed below:

	Ambient temperature (degrees Celcius)	Notes
Operating range	-10 ... +55	GSM phase2 requirements fulfilled.
Extended operating range	-20 ... +70	Device works but not necessarily fulfill all GSM requirements.
Storage	-30 ... +70	except battery
Long time storage (sales package)	0 ... +30	

Allowed ambient relative humidity :

	Ambient relative humidity	Notes
	5 ... 95 %	except battery

The transceiver is not protected against ingress of water. The transceiver may be instantaneously subjected to dripped or condensed water. Longer term contact with water will cause permanent damage.

Warnings and Restrictions

See the User Manual.

Functional Description

The Communicator comprises two functionally independent units: PDA and CMT.

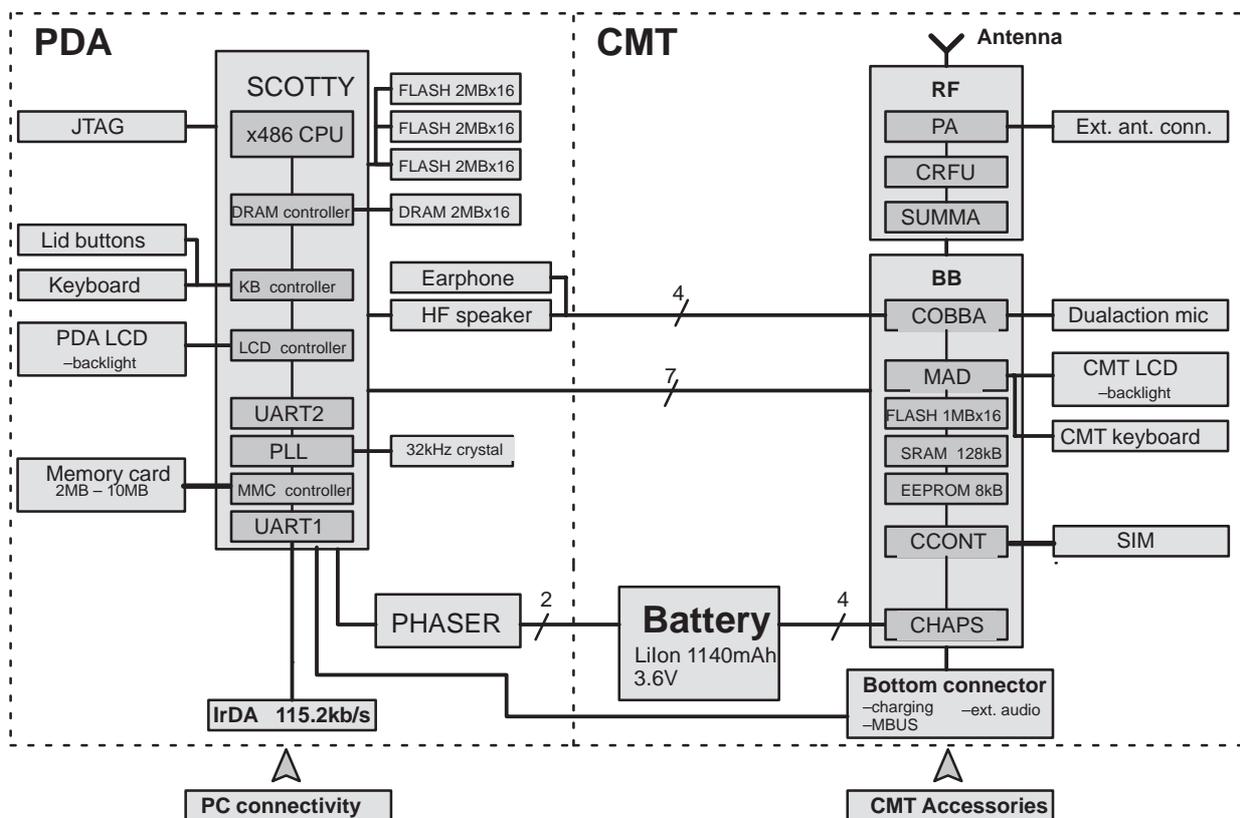
The PDA implements the communicator application platform.

The CMT implements the GSM transceiver and basic data functionality, both transparent and non-transparent data. All UI functionality is combined into one UI module (BS2) but both PDA and CMT control their respective UI independently.

The Functional units and the implementation differ slightly. Due to mechanical reasons some components are placed into a different module than they functionally belong. E.g. audio components are placed into BS1 (PDA) module even if they functionally belong to the CMT.

Block Diagram

The following diagram describes the functional RAE-2N block diagram.



PDA Module

The PDA module has its own power management chip, the Phaser. The Phaser regulates the voltages for PDA components. It also controls PDA power-up/down procedure by providing POWERGOOD and RESET signals to Scotty.

The PDA processor Scotty is an embedded 486 processor manufactured by AMD. The Scotty contains a set of PC peripherals except a parallel port. It also has some additional peripherals like LCD controller and MMC host controller which are not standard to PCs. CPU has a 8k cache.

The PDA interfaces the CMT with 115kbps serial bus (FBUS). It also provides low frequency clock (32kHz) to CMT. PDA also can get information about CMT state (on/off) and wake up CMT.

CMT Module

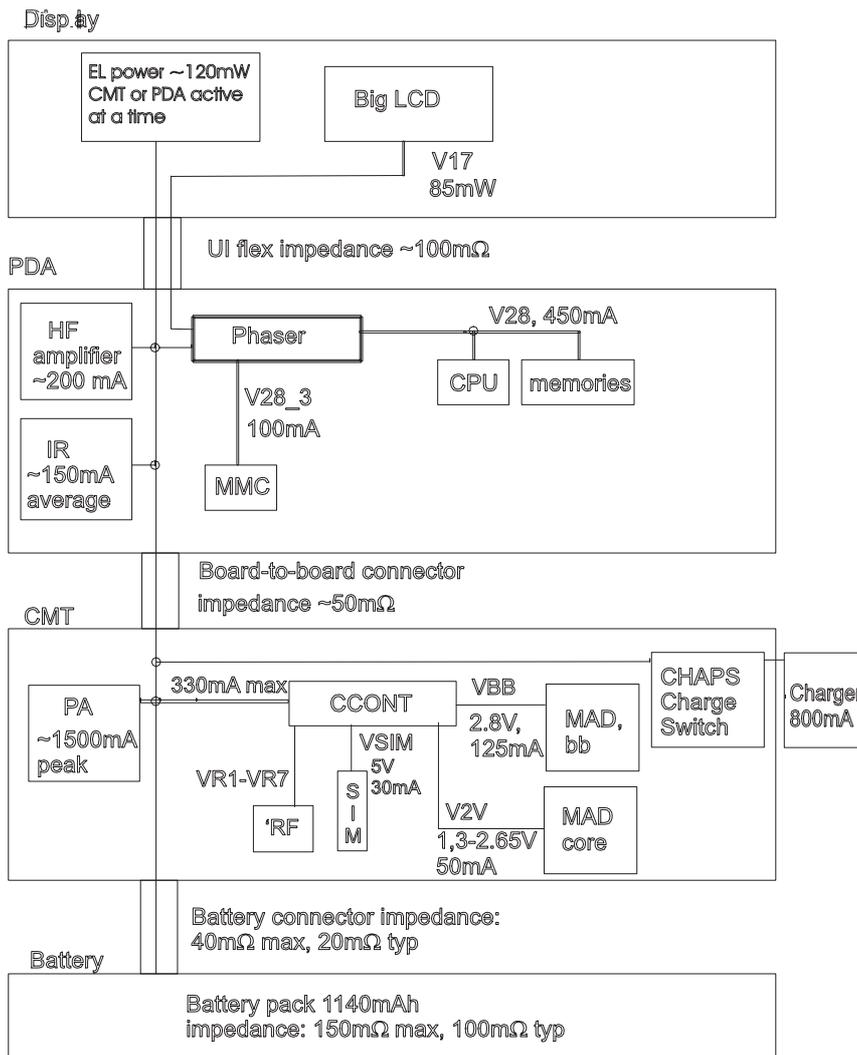
The CMT is based on DCT3 engine and it is functionally the same. Sleep clock (32kHz) is received from PDA side.

All the audio components are controlled by CMT (COBBA). If PDA wishes to play sounds those are first sent to CMT. Keyclicks and some system sounds are exceptions and are played directly by PDA.

Power Distribution

All the digital circuitry modules use 2.8V nominal operating voltage. Power is drawn from 1140mAh Li-Ion battery. Higher voltages are generated for LCD, SIM and backlighting.

The diagram below describes the power distribution of the product.



Audio

The transceiver has two speakers; earpiece for the telephone interface and handsfree (HF) speaker. Different kind of tones can be played through speakers. HF speaker is driven only by CMT module. The earpiece can be driven either by the PDA or the CMT. The transceiver has one microphone connected to the CMT module.

The speakers are used :

- 1 HF speaker:
Ringing tones
All PDA tones that can be WAV-type
Talk when HF speaker is enabled
- 2 Earpiece:
Talk and WAV-sounds when HF disabled
Keyclicks
Fixed PDA tones

Software Specifications of Interfaces

CMT SW is based on HD943. This product program has added internal data functionality and ECI message interface.

External Devices

External devices can be connected through serial cable (DLR-2) or IR. The protocols used are:

IrOBEX (ir-connectivity),

UltraIR (DCT3 connectivity),

IrDA (PC-connectivity)

IrTranP (camera connectivity).

The PC connectivity uses a specific PCCOM protocol on top of the IrDA or serial connection.

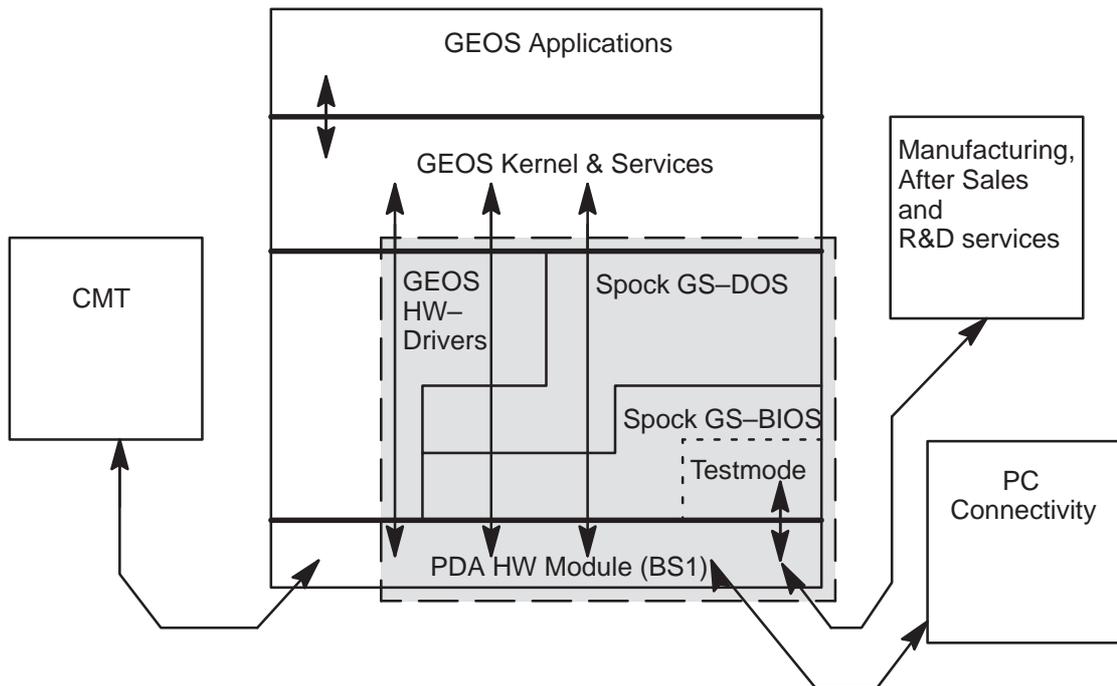
Interfaces Between Transceiver Processors

PDA and CMT processors interface through serial FBUS channel. On top of the physical FBUS link two separate protocols are used. The Phonet protocol is used to transport CMT related control information and data-frames. "RBUS" is used to transport ECI (External Control Interface) messages between PDA UI and CMT.

Software-Hardware Interface

CMT sw/hw interface is the same as hd940 is using.

PDA software is running on AMD Elan SC450 processor. Operating frequency is 33MHz.



The lowest level of HW/SW interface is handled by the BIOS which provides some basic services for upper sw layers. E.g. read data from memory card.

Testmode is used by production and After Sales. It provides the interface to test and program PDA and CMT modules.

DOS layer implements only a subset of DOS functions known from conventional PC. DOS is used mainly in testmode and to launch GEOS.

GEOS is the basic SW platform to all applications that user sees. It however interfaces directly to some HW resources, like LCD display or serial ports, by its own HW drivers.

Alignment

Both PDA and CMT modules require alignment. Alignment is done at module level to modules BS8 and BS1. LCD temperature measurement can be done only after the assembly of the product.

The following parameters are adjusted in CMT module (BS8): TX power, RSSI, AFC, TX I&Q, battery voltage and charging current.

PDA module (BS1) needs alignment of: battery voltage, LCD contrast voltage.

Alignment is software based. Predefined reference point measurements are stored into EEPROM (CMT) or flash (PDA).

Flashing

Product requires two separate flash images for executable code: one for the CMT and one for the PDA system. Language versions are held in separate files.

CMT flashing uses partly the same equipment as other DCT3 family products.

PDA flashing can be done with JTAG (low level flashing) or WinTesla. WinTesla flashing is recommended.

Vocabulary

AMD	Advanced Micro Devices
BIOS	basic input/output system
CMT	cellular mobile telephone
FSTN	Film compensated Super Twisted Nematic
HF	Hands Free
IR	infra red
IrDA	IR data association
MMC	Multi Media Card
PDA	personal digital assistant
RX	receive
TX	transmit