

PAMS Technical Documentation

RAE-3NU* Series PDA

4. User Interfaces

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Abbreviations

AC	—	Alternating Current
KL9	—	RAE-3NU* Main PWB
CMT	—	Cellular Mobile Transceiver
CCFL	—	Cold Cathode Fluorescent Lamp
DL1	—	Linda Display module including PWB and displays
ESD	—	Electro Static Discharge
FPC		Flexible Printed Circuit
FSTN	—	Film Compensated Super Twisted Nematic
LCD	—	Liquid Crystal Display
LED	—	Light Emitting Diode
MCU	—	Micro Computer Unit
PWB	—	Printed Wiring Board
PDA	—	Personal Digital Assistant
UI	—	User Interface
UIF	—	User InterFace
UL1	—	DL1 PWB submodule

RAE-3NU* User Interface Structure

RAE-3NU* GSM900/GSM1800 Dual Band Communicator User Interface comprises the QWERTY keyboard module UL8 and the DL1 module with both displays.

User Interface DL1

This section describes the DL1 module. This module includes

- a PWB (UL1) with SMD components,
- PDA display (including white LED backlight),
- CMT display with frame and lightguide and
- CMT keypad backlights.

DL1 is located in the cover side of RAE-3NU*. Figures below describe the two sides of the module.

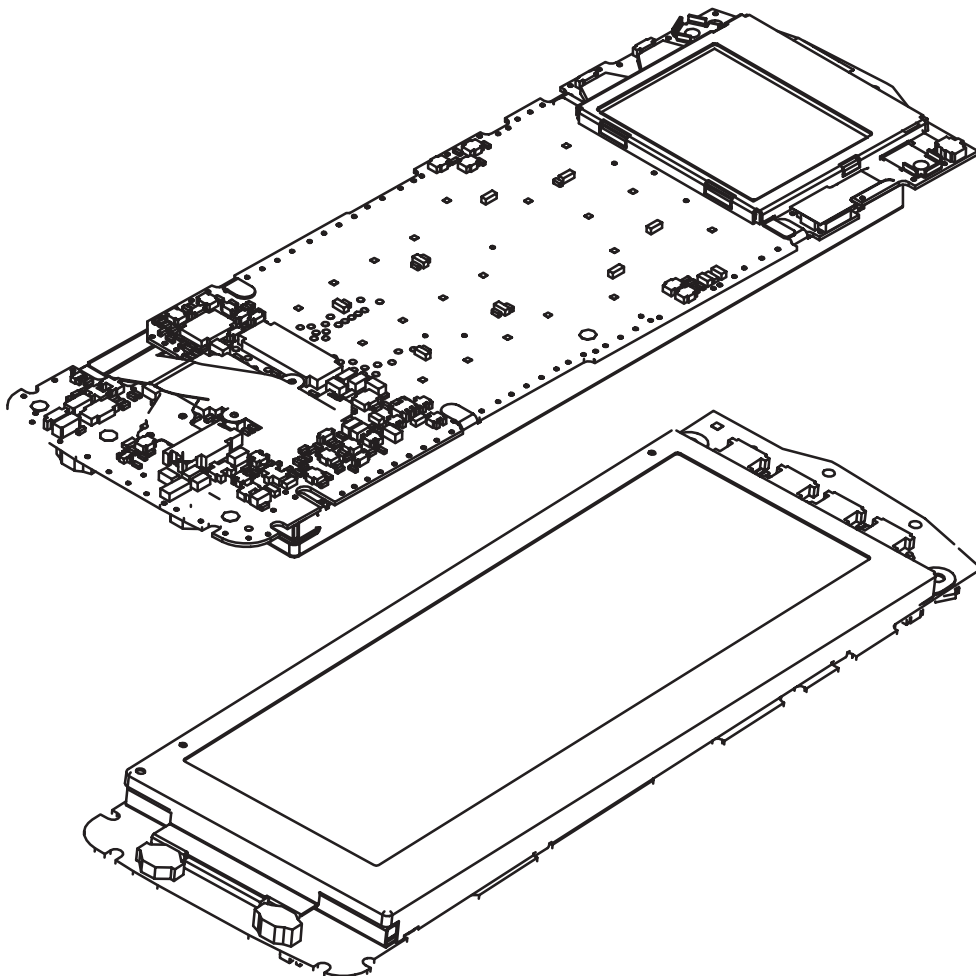


Figure 1. DL1 module

Main Components

DL1 main components include UL1 PWB with components, PDA display and CMT display.

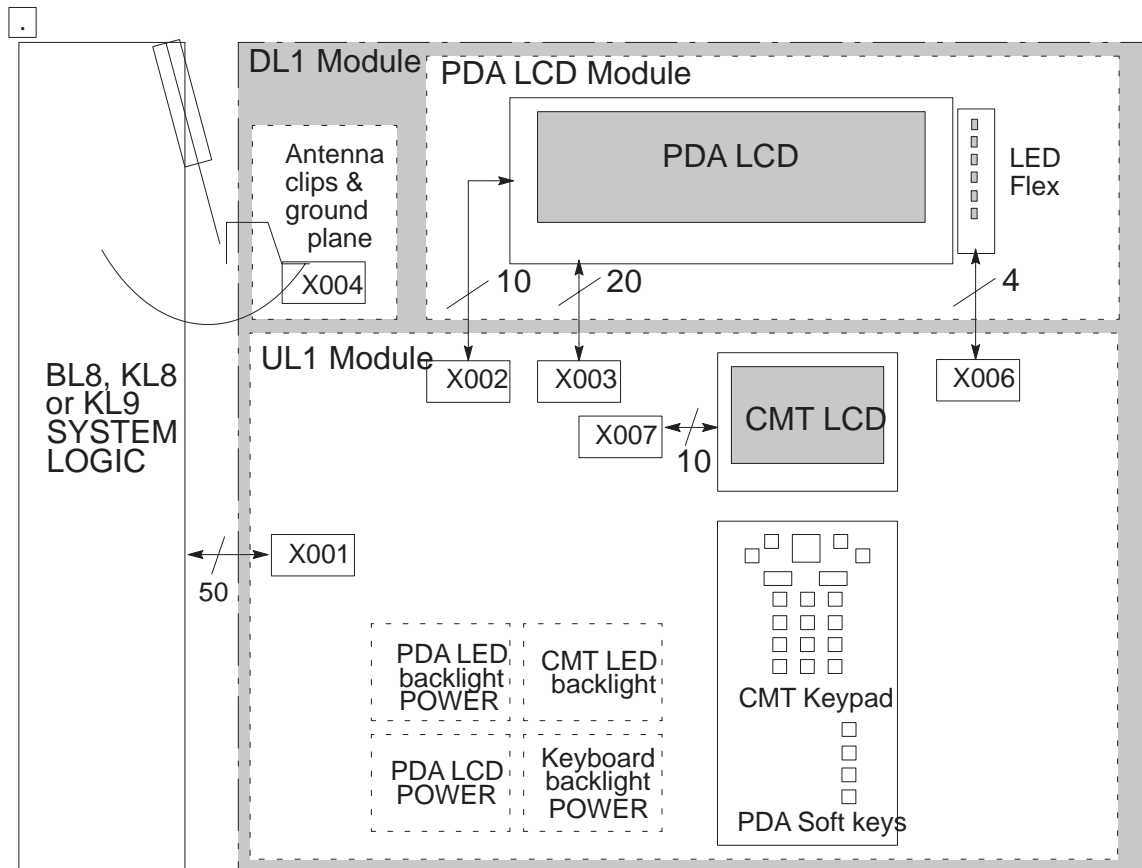


Figure 2. DL1 Module Block Diagram

Components on the module assembly include the following:

- Four layer, 0.6mm thick PWB (UL1) including:
 - LED backlight circuit for PDA LCD.
 - Power circuit for PDA LCD bias voltages.
 - Power circuit and LEDs for CMT keypad and CMT display backlight.
 - Antenna connection point and ground plane.
 - Coaxial cable connector for antenna cable.
 - 10-pin and 20-pin flex connectors for PDA display module.
 - 50-pin flex connector for KL8 module.
 - 10-pin flex connection for CMT display.
 - 4-pin stacker connection for LED flex assembly.
 - Pads for CMT keypad.
 - 4 pieces PDA soft key switches.

- PDA LCD module including lightguide, LED FPC for 6 pcs white LEDs and metal frame.
- CMT Display module including metal frame and lightguide.

DC Characteristics

Supply voltages and power consumption are listed below:

Conn./Pin	Line Symbol	Parameter	Minimum	Typical	Maximum	Unit	Notes
X001/1, X001/49, X001/50	VB	Battery Voltage	3.0	3.6	4.2	V	4.8V Absolute maximum
					210	mA	
X001/11	VBB	Logic voltage	2.7	2.8	2.9	V	
					20	mA	

Connections

The 50-way FPC X001 connects the DL1 to the KL8 (system logic and RF board) via the hinge. The KL8 comprises all active signals for the DL1 module and supply pins. It is connected to the 50-pin board-to-board connector X001.

DL1 includes a coaxial cable connector X004 for antenna cable. This co-axial cable goes through the hinge to the KL8 RF part.

DL1 includes an antenna connection point to which the antenna is connected.

X001 Hinge flex connector

X001 is a 50-pin board-to-board connector. It is used to interface signals between DL1 module and KL8 module through UL8 module.

PIN/ Pins	Line Symbol	Parameter	Min.	Typ. / No m.	Max.	Unit	Active level	Function
1,49 50	VB	Battery voltage	3.0	3.6	4.2	V		Supply
11	VBB	Logic voltage	2.7	2.8	2.9	V		Supply
3, 7, 19, 26, 37, 38, 44, 48	GND	Ground		0		V		Supply
21	LCDPWR	PDA LCD Voltages switch	0 1.58V		0.88V VBB	V	Inactive Active	Input. High level turns on back-light and supply to display

PIN/ Pins	Line Sym- bol	Parameter	Min.	Typ. / No m.	Max.	Unit	Active level	Function
16	GenSClk	Serial Clock for CMT display	0	3.25	4.0	MHz		Input
			0 0.7xVBB		0.3xVBB VBB	V	Low High	Input
18	GenSDIO	Serial Data for CMT display	0 0.7xVBB		0.3xVBB VBB	V	Low High	Input
46	Row5LCDC D	CMT display con- trol / data	0 0.7xVBB		0.3xVBB VBB	V	Control Data	Input. Low level se- lects com- mand regis- ter
15	LCDEN	CMT display en- able	0 0.7xVBB		0.3xVBB VBB	V	Active Inactive	Input. Low level en- ables writ- ing to the display
13	LCDRSTX	CMT display reset	0 0.7xVBB		0.3xVBB VBB	V	Active Inactive	Input. Low level resets the display
14	KBLIGHTS	CMT keypad and display backlight control	0 0.7xVBB		0.3xVBB VBB	V	Active Inactive	Input. High level turns lights on.
22	LCDDa0	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
2	LCDDa1	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
4	LCDDa2	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
33	LCDDa3	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
8	LCDDa4	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
31	LCDDa5	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
32	LCDDa6	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
6	LCDDa7	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
9	LCDDa8	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
5	LCDDa9	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
34	LCDDa10	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input
20	LCDDa11	PDA display data	0 1.58V		0.88V VBB	V	Low High	Input

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PIN/ Pins	Line Sym- bol	Parameter	Min.	Typ. / No m.	Max.	Unit	Active level	Function
25	DISPClk	PDA display Pixel clock	8	8.66	10	MHz		
			0 1.58V		0.88V VBB	V	Low High	Input
35	LLCk	PDA display Line pulse	0	10.8	12.5	kHz		
			0 1.58V		0.88V VBB	V	Low High	Input
23	FSP	PDA display Frame pulse	0	51.5	59	Hz		
			0 1.58V		0.88V VBB	V	Low High	Input
10	LCDM	PDA display AC- modulation	0	10.8	15	kHz		
			0 1.58V		0.88V VBB	V	Low High	Input
24	DISPON	PDA display ON/ OFF	0 1.58V		0.88V VBB	V	Active Inactive	Input
36	LCD_TEM P	Connected to ground for color display detection.						Unused.
30	Col0	Keypad column 0	0 0.7xVBB		0.3xVBB VBB	V	Low High	Input
27	Col1	Keypad column 1	0 0.7xVBB		0.3xVBB VBB	V	Low High	Input
28	Col2	Keypad column 2	0 0.7xVBB		0.3xVBB VBB	V	Low High	Input
43	Col3	Keypad column 3	0 0.7xVBB		0.3xVBB VBB	V	Low High	Input
45	Col4	Keypad column 4	0 0.7xVBB		0.3xVBB VBB	V	Low High	Input
29	Row0	Keypad row 0	0 0.7xVBB		0.3xVBB VBB	V	Low High	Output
39	Row1	Keypad row 1	0 0.7xVBB		0.3xVBB VBB	V	Low High	Output
40	Row2	Keypad row 2	0 0.7xVBB		0.3xVBB VBB	V	Low High	Output
41	Row3	Keypad row 3	0 0.7xVBB		0.3xVBB VBB	V	Low High	Output
42	Row4	Keypad row 4	0 0.7xVBB		0.3xVBB VBB	V	Low High	Output
17	LCDPWM	PDA LCD Con- trast control	0 0.7xVBB	50.7	0.3xVBB VBB	V KHz	Low High	Input
47	BACKPWM	PDA LCD Back- light control	0 0.7xVBB	335	0.3xVBB VBB	V Hz	Low High	Input

Interface to PDA LCD module row driver X002 connector

X002 is a 10-pin flex connector. It connects power and control signals to the row driver of the PDA LCD module.

Pin	Line Symbol	Minimum	Typical / Nominal	Maximum	Unit	Notes
1	GND		0		V	LCD driving level for Y driver IC
2	XINH	0 0.8 x VDDY	Logic 0 Logic 1	0.2 x VDDY VDDY	V	Line sub-sampling signal for Y driver IC
3	YSCL	0 0.9 x VDDY	Logic 0 Logic 1	0.1 x VDDY VDDY	V	Shift clock for Y driver IC
4	FRY	0 0.8 x VDDY	Logic 0 Logic 1	0.2 x VDDY VDDY	V	Output control for Y driver IC
5	VCCY	2.7	VCC-V5Y 3.3	4.5	V	High level supply voltage for Y driver IC
6	V5Y					Low level supply voltage for Y driver IC
7	NC					Not connected
8	V0Y	8.0	V0Y-V5Y-VDD	33	V	LCD driving level for Y driver IC
9	VDD					LCD driving level for Y driver IC
10	DY					0 0.8 x VDDY

PDA LCD module column driver X003 connector

X003 is a 20-pin flex connector. It connects data and control signals to the column drivers of the PDA LCD module

Pin	Line Symbol	Minimum	Typical / Nominal	Maximum	Unit	Notes
1	VCC				V	Logic supply for X driver
2	VDDH				V	LCD supply for X driver
3	D23	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
4	D22	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
5	D21	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal

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Pin	Line Symbol	Minimum	Typical / Nominal	Maximum	Unit	Notes
6	D20	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
7	GCP	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	PWM width control pulse for X driver
8	FR	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Output alternation signal for X drivers
9	LP	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Data load and shift pulse for X driver
10	RES	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	PWM counter reset signal for X driver
11	D03	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
12	D02	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
13	D01	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
14	D00	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
15	XSCL	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Shift clock for X driver
16	D13	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
17	D12	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
18	D11	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
19	D10	0 0.7 x VDDX	Logic 0 Logic 1	0.3 x VDDX VDDX	V	Digital video signal
20	GND		0		V	Logic Low signal for X driver, LCD low level for X driver

Interface to LED FPC X006 connector

X006 is a 4-pin 'stacker' connector that connects the PDA LCD backlight power supply to LED backlight FPC located in the PDA LCD module.

Pin	Line Symbol	Parameter	Minimum	Typical / Nominal	Maximum	Unit	Function
1, 2	High (common)	LED driver output voltage	0	0.84	1.54	V	Maximum brightness level (D 100%)
		Output current		32		mA	
3	Low (ser.#1)	Brightness control voltage, LEDs 1 – 3	0.268	0.292	0.316	V	Maximum brightness level (D 100%)
		LED current		16		mA	
4	Low (ser.#2)	Brightness control voltage, LEDs 4 – 6	0.268	0.292	0.316	V	Maximum brightness level (D 100%)
		LED current		16		mA	

Note: adjusting the brightness level changes the Output and LED current values in the table above.

Interface to CMT LCD module X007 connector

X007 is a 10-pin flex connector that connects CMT LCD signals to the CMT LCD module

Pin	Line Symbol	Parameter	Minimum	Typical / Nominal	Maximum	Unit	Notes	Function	
1	GND	Ground		0		V		Supply	
2	VOUT	DC/DC voltage converter output			9				Input
3	LCDRSTX	Reset	0		0.3xVBB		Active	Output	
4,5	VBB	Supply voltage	2.7	2.8	2.9	V		Supply	
					300	uA			
6	GenSClk	Serial clock input	203kHz	3.25MHz	3.25MHz	MHz		Output	
6			0 0,7xVBB		0.3xVBB VBB	V	Low High	Output	
7	GenSDIO	Serial data input	0		0.3xVBB	V	Low High	Output	
			0.7xVBB		VBB	V			
8	Row5LCD CD	Control/display data flag input	0		0.3xVBB		Control Data	Output	
			0.7xVBB		VBB				
9	LCDEN	Chip select input	0		0.3xVBB VBB		Active Inactive	Output	
10	OSC*	External clock for LCD					Connected to VBB on UL1	Inactive	

Interface to RF module

X004 is a coaxial connector that connects the antenna to the RF parts of the KL8 module.

Pin	Line symbol	Parameter	Minimum frequency	Maximum frequency	Maximum power	Notes
	RF	Antenna feed cable	890 MHz	1880 MHz	33 dBm (peak) 28.8 dBm (average)	

Functional description

Power distribution and control signals

The following block diagram describes the distribution of power supplies within DL1.

Battery voltage VB is fed directly to the illumination LEDs (CMT keymat and CMT display)

Battery voltage is also connected to the DC/DC converter making the driving voltage for the 6 pcs white LEDs providing the PDA display backlight.

The regulated power supply VBB generated on the KL8 module supplies the CMT display, control logic and PDA display supply.

A power switch is used to remove the voltage supply from the control logic and PDA display when the display is turned off.

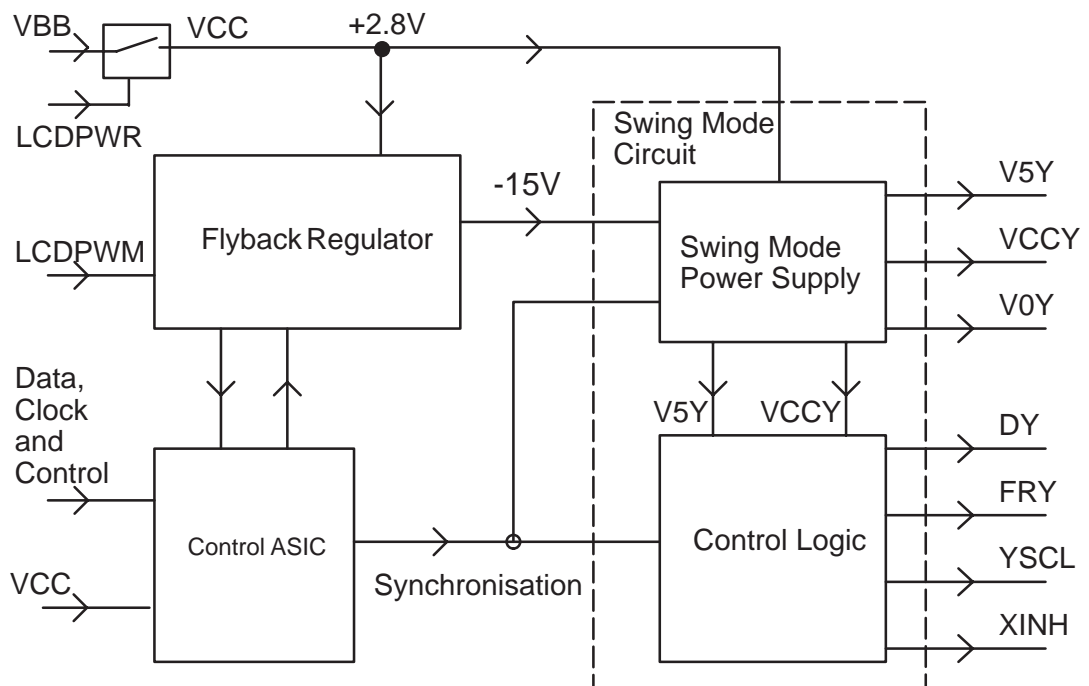


Figure 3. Power distribution and control signals of UL1.

DL1 Circuit Description

The module is connected via a 50 way FPC to the KL8 system logic.

The module includes following main blocks:

- CMT keyboard geometries.
- Switches for PDA soft keyboard
- Backlight LEDs for CMT keypad and CMT LCD illumination.
- CMT LCD.
- PDA LCD module.
- PDA LCD backlight circuit.
- PDA LCD power circuit.
- PDA LCD interface control logic.
- Hinge flex connector.
- Antenna connector and ground plane.

Keypad scanning.

There are 24 keys located in DL1 module. 4 pcs PDA soft keys are located inside the lid and 20 pcs CMT keys on the outer side. All these keys are in the same keyboard matrix as the QWERTY-keypad in the UL8 module.

Col(0–4) are used as column lines in keypad. Row(0–4 and 6) are used as row lines.

When a key is pressed the MCU gets an interrupt from a row and starts scanning. One column at a time is written low and rows are used to read which key is pressed.

CMT keypad and CMT LCD backlight

The CMT keypad and CMT display are illuminated with LEDs. Each LED is driven by a separate drive transistor.

LEDs for CMT display are driven with approximately 10mA each.

LEDs for CMT keymat illumination are driven with approximately 2.5mA each.

CMT LCD module

Mechanical structure

LCD includes the frame, LCD cell with driver chip, reflector, adhesive tapes, and lightguide. The LCD is electrically connected to the UL1 PWB with a FPC and board-to-board connector X007.

The frame includes clips to mechanically attach the display to the UL1 PWB and also keep LCD cell and lightguide in place.

PDA LCD Module .

PDA LCD circuit main blocks are :
 LCD glass including drivers
 PDA LCD bias voltage power circuit
 control IC.

Parameter	Function
Display resolution	640 (x3) x 200 dots
Active area	107.52 x 33.6
Dot pitch	0.168 x 0.168mm
Display mode	D-TFD, Color, Transmissive
Frame frequency	51.5 Hz typical
Colors	4096 colors, 12-bit RGB
Display brightness	100nit (full brightness typical)

PDA LCD Backlight circuit

Fig. 3 describes the PDA LCD backlight circuitry. The basic blocks include a Switched Mode Power Supply (SMPS) in step-up configuration , Brightness control circuit and LED FPC.

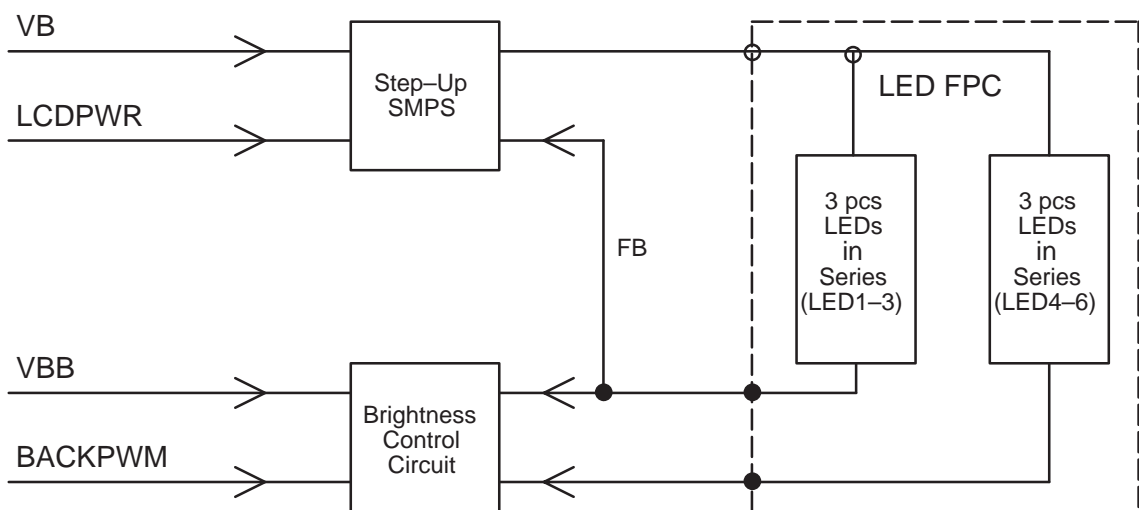


Figure 4. Backlight Power Supply

LED FPC

LED FPC is part of the backlight system which is located in PDA LCD Module. Connection between the PDA LCD Backlight power circuit located on UL1 and LEDFPC is achieved with "Stacker" connector X006.

LED FPC consists of 6 pieces of white LEDs in two chains (LED1-3 and LED4-6). Each chain of LEDs has 3 pieces of LEDs in series connection. Thus the LED current through all the LEDs in one chain is equal.

Both LED chains have a common driving voltage from switched mode power supply. The other end of the LED chains have separate input pins for Brightness Control Circuit. LED FPC also comprises two zener diodes for ESD protection. These diodes are located across the LED chains so that each diode is parallel with three LEDs in series.

Step-Up Switched Mode Power Supply

Main component of this block is LM2621 Step-Up SMPS. LM2621 combines a step-up switching regulator, N-channel powerMOSFET, built-in current limit, thermal limit and voltage reference in a single package.

Step-Up SMPS is used for generating nominal voltage of 11.7V for white LEDs from battery voltage which changes between 3.0V and 4.2V. However output voltage of the SMPS varies according to the variations in Forward Voltages of the three LEDs in series. Two parallel LED chains are connected between the output voltage of the SMPS and feedback pin (FB) of the LM2621. Between the feedback pin and ground there are feedback resistors that set the current which runs through the LEDs.

Brightness Control Circuit

The light output is dimmed during normal operation to conserve power. This is achieved inside Brightness Control Circuit with a PWM control signal from baseband (BACKPWM).

Brightness Control Circuit consists of the feedback resistors for LM2621 switched mode power supply. Total resistance of the feedback resistors can be changed by using the BACKPWM signal. This resistance value then sets the current through the first LED chain LED1-3. There is also the current mirror circuit inside the block.

Current mirror copies the current from the first LED chain LED1-3 to the second LED chain LED4-6. Thus setting the equal current through each LED. Feedback resistors set the LED current in LED1-3 chain. BACKPWM signal is used for controlling the brightness. If PWM duty cycle is set to 100% then the maximum current of approximately 16.2mA through the LED1-3 chain is driven. If PWM duty cycle is set to 0% then the minimum current of approximately 1.8mA is driven.

PDA LCD Power circuit

PDA LCD power circuit generates the bias voltages necessary for the PDA display panel. Block diagram below.

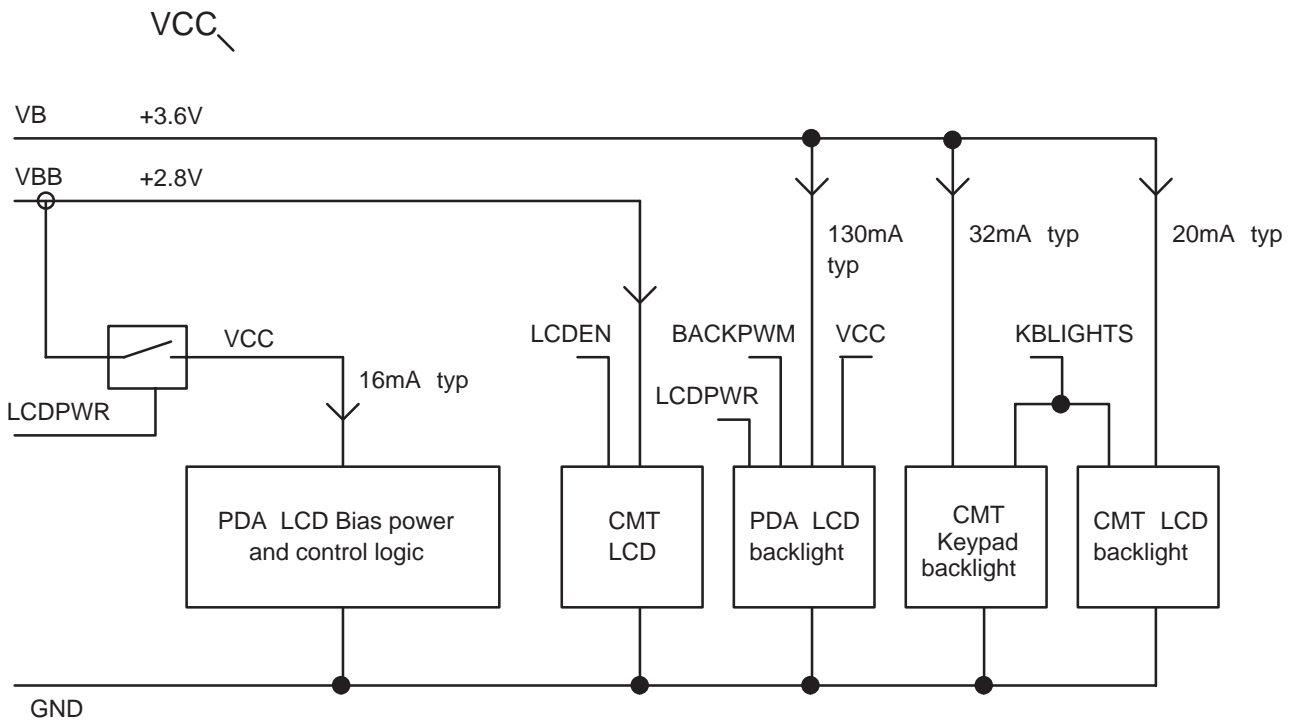


Figure 5. Block diagram of PDA Power Supply

The flyback regulator generates a negative bias voltage (Nominally $-15V$) from the battery voltage. The output of the flyback generator is temperature compensated and adjusted under software control.

The control ASIC handles the refresh of data to the PDA display panel and the generation of synchronisation signals for the swing mode regulator.

Antenna connectors and ground plane

The RF-signal from the external antenna connector/switch on KL8 is fed to the antenna via a coaxial cable that is led through the hinge. The signal is fed to the antenna through a coaxial connector and an antenna clip which are placed on the UL1 PWB.

The UL1 PWB includes the separate ground area that is required by the antenna.

QWERTY Keyboard Module UL8

General

UL8 is the combined QWERTY keypad/flex connection module. The base flex is single-sided, so all the components are on the same side of the flex.

Approximate component placement is shown below:

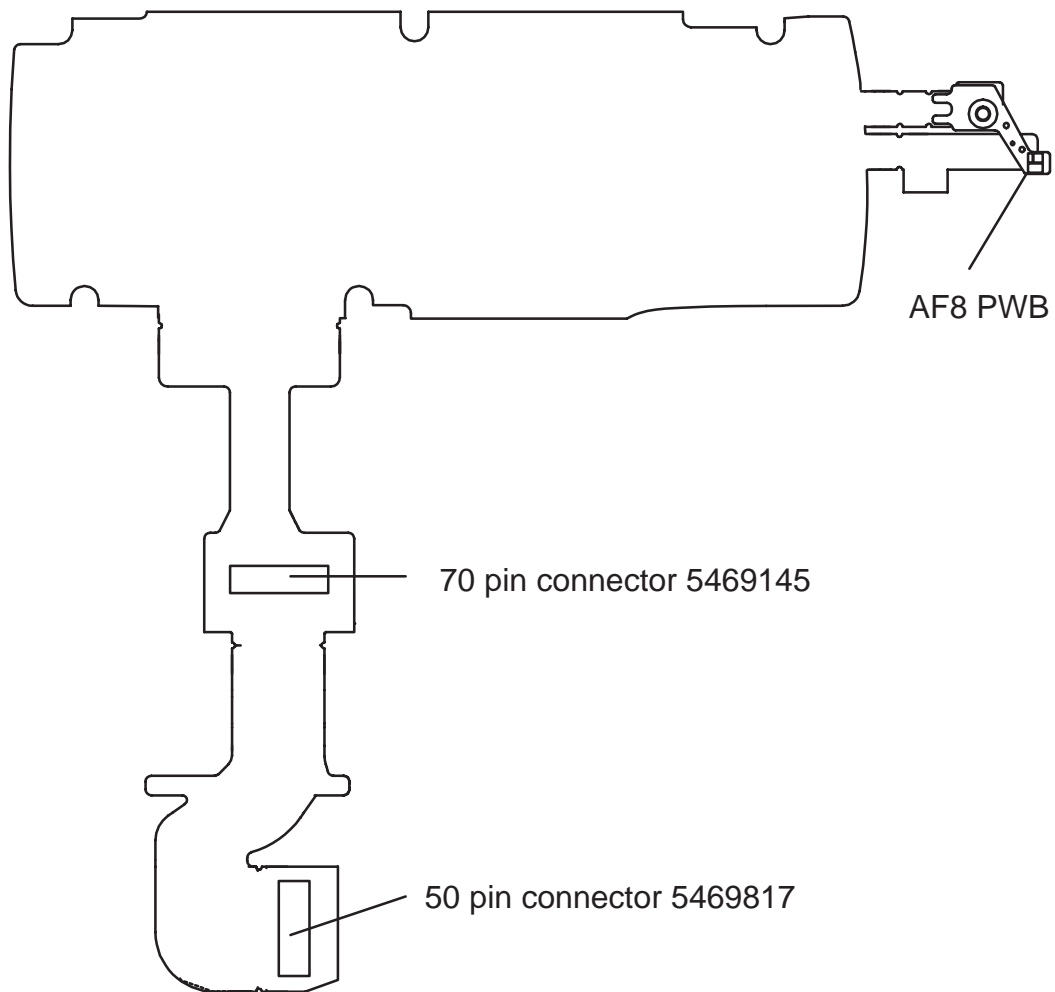


Figure 6. Component placement

AF8 PWB

AF8 is a small additional PWB to achieve "bull's eye" shaped pads for the ear-piece and connection for the battery removal switch.

Note that the battery removal switch detection is disabled in KL9 software.

The approximate shape of AF8 is shown below.

One 22pF SMD capacitor is assembled to the AF8.

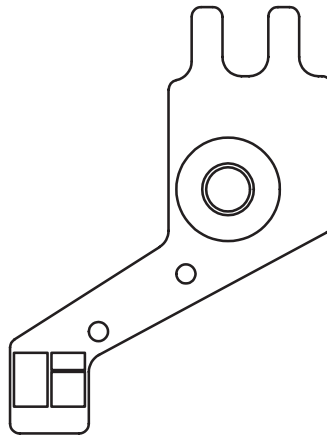


Figure 7. AF8 PWB