APPLICATION NOTE

Outline Specification CCA210S, microcontroller for a CD/Radio/ Cassette recorder system. V1.0

AN96017

Abstract

CCA210 is a micro computer controlled FM/MW/LW/SW radio system, (for battery and mains-fed portable, micro and mini audio systems), based on the TEA5757 STR radio system (STR = Self Tuned Radio), combined with a CD player mechanism performing all the functions of a CD player. This report gives an outline of the system describing system features and components.

"The purchase of Philips' complete set of Integrated Circuits as specified in this Application Note for manufacture of a radio system conforming the relavant specification as herein given, secures immunity from suit on unauthorized use of those Philips' patent rights, which specifically relate to automatic broadcast station storage (AST) and/or radio data system (RDS) features."

Purchase of Philips I^2C components conveys a license under the Philips I^2C patent to use the components in the I^2C system, provided the system conforms to the I^2C specifications defined by Philips.

APPLICATION NOTE

Outline Specification CCA210S. V1.0

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Keywords

Digital Tuning
CD Player
Cassette Recorder
Remote Control
Battery and Mains-fed

Date: February 1996

Summary

CCA210 is a micro computer controlled FM/MW/LW/SW radio system, (for battery and mains-fed portable, micro and mini audio systems), based on the TEA5757 STR radio system (STR = Self Tuned Radio), combined with a CD player mechanism performing all the functions of a CD player. CCA210S is the controlling micro controller, it takes care of all radio functions as well as the CD servo processing. The main features are listed below.

Tuner:

- Digital tuning for FM, MW, LW and SW band;

- Analog search next/previous station;

- Automatic analog fine tuning;

- Store and recall 5 or 10 presets per band;

- Preset scan function;

- AST (Automatic Store Tuning) for each band;

CD:

- CD incorporates a three-beam mechanism and motorised tray loader;

- Full CD control including: random and scan play, track programming features, track/search up/down control, A-> B repeat, track and disc repeat, direct track selection, various display formats and a service mode.

Tape:

- CD record synchronisation;

- Tape play detection;

Audio:

- Volume up/down control by means of a motorised potentiometer;

- Electronic volume/bass/treble/balance control optional;

Clock and Timer:

- Clock function in stand-by;

- Various on/off timer functions;

- Sleeptimer up to 90 min.;

Non Volatile Memory, optional:

- Storage of preset, audio and timer status;

Keys:

- RC-5 remote control;

- Up to 36 local keys possible;

CONTENTS

REVISION HISTORY

Version	Remarks
Version 1.0	First release

1. INTRODUCTION

CCA210 is a micro computer controlled system consisting of a FM, MW, LW and SW stereo radio with a three-beam CD system. It is based on a single micro controller (OM5234) and various bus controlled peripherals.

The system contains functions such as search tuning, preset control, input source switching, full CD control, volume control, interface for a mechanical controlled tape deck, LCD display.

The radio control and CD servo processing are combined in a single micro controller.

CCA210 can be used to built an application for a battery and mains-fed powered, micro or mini audio system.

2. BLOCK DIAGRAM OF THE SYSTEM
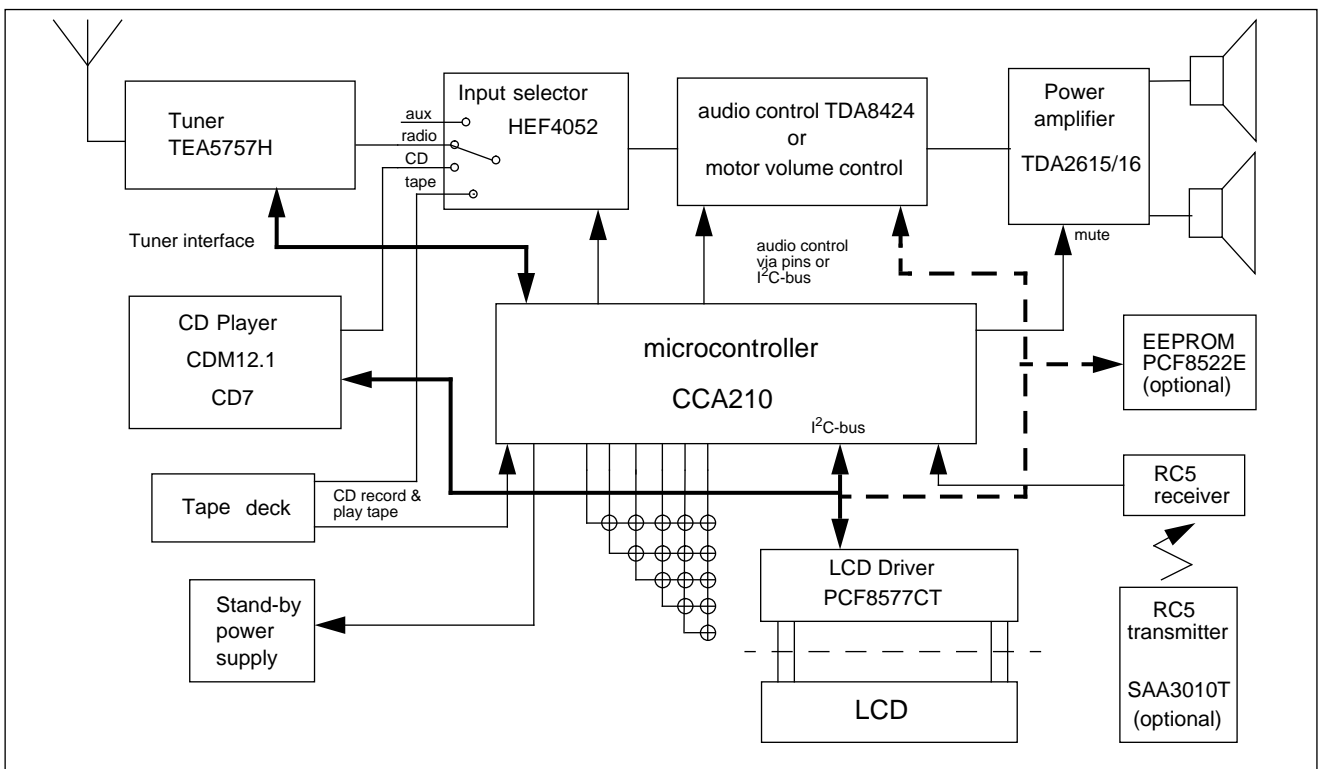
The block diagram of CCA210 is given in the figure below.

Fig.1 Block diagram of CCA210S.

BLOCK DIAGRAM OF THE SYSTEM　　　　　　**Application Note**
AN96017

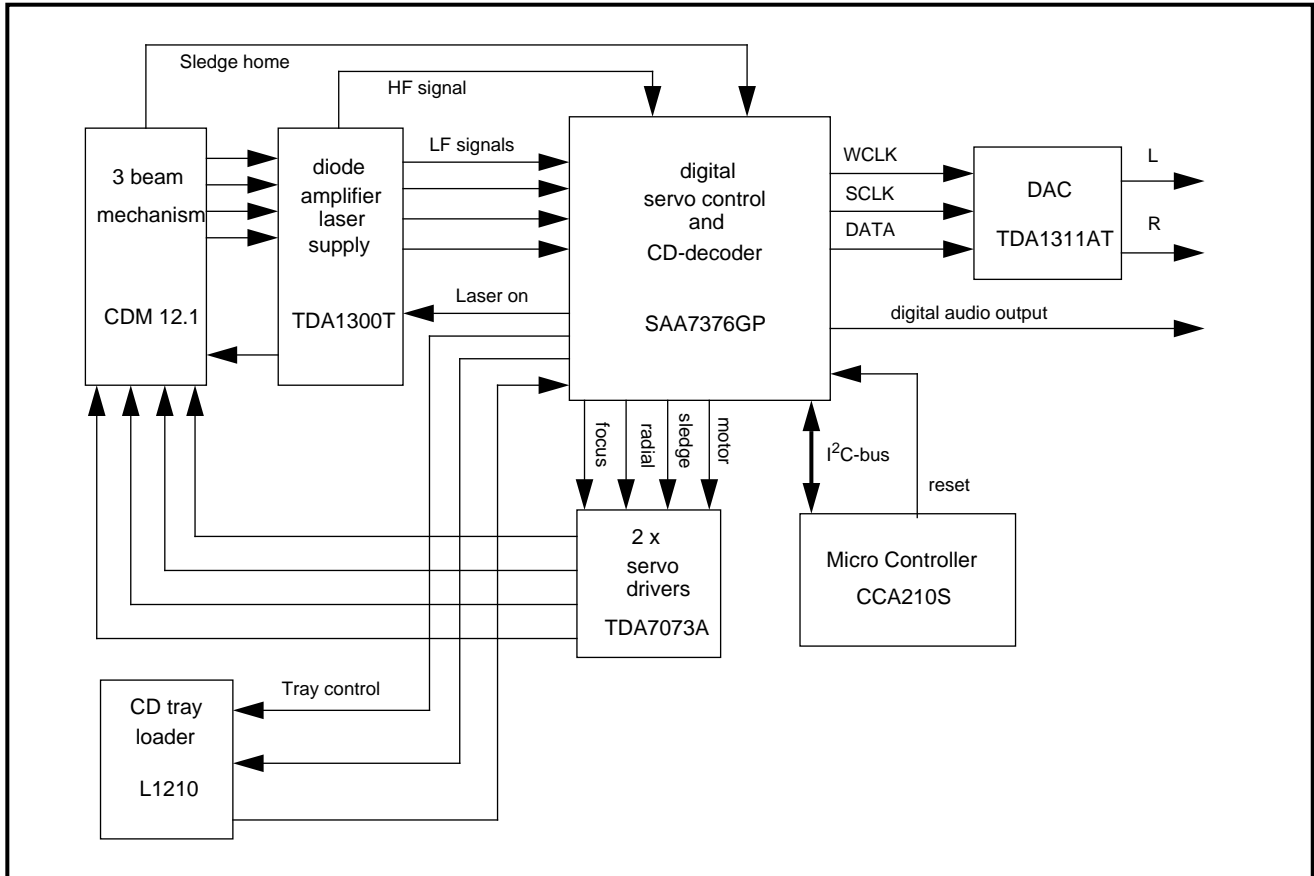The block diagram of the CD subsystem is given below.

Fig.2 Block diagram of the CD subsystem.

A short description of the used ICs is given below:

OM5234/FBP/..
CCA210S mask programmed micro controller.

TEA5757H
AM/FM receiver including synthesizer and stereo decoder. The inherent Fuzzy Logic behaviour of STR (Self Tuned Radio), which mimics hand-tuning, yields a potentially fast yet reliable tuning operation. Search for next/ previous station is fast, due to the analog solution. The search requires no IF-counter for stop detection.

TDA1300T
(DALaS) Digital Amplifier and Laser Supply IC, Performs buffering of the diode signals for the servo, and amplification and equalisation of the HF signal for the decoder.

TDA7073A(T)
Dual stage linear power amplifier IC, (2x).

SAA7376GP

(CD7) CMOS Digital Servo and Decoder IC for CD. Performs decoding and de-interleaving of the EFM data signal, plus error correction/concealment and digital filtering. Equipped with onboard SRAM. Also provides control of the spindle motor speed, plus the digital servo control functions. Communication with the micro controller via the I^2C-bus.

TDA1311A(T)

(CCDAC) Continuous calibration Digital-to-Analogue Converter. Dual channel with voltage output and 16 bit EIAJ format digital input.

CDM12.1

Three-beam mechanism with single Foucalt Focus error detection and LDGU (Laser Detector Grating Unit) holographic pick-up. Used in conjunction with tray loader L1210.

L1210

CD tray loader (optional).

HEF4052

Input source selector (radio/CD/tape/aux).

TDA8424

I^2C-bus controlled Hi-Fi audio processor for home audio systems. Includes volume, balance, bass, treble and mute control. (optional).

TDA2515/16(Q)

2 x 10/20 W (maximum output power) Hi-Fi audio power amplifier with mute.

PCF8577CT

LCD driver IC. Provides 32 segment-drive lines with 2 backplane select lines (64 segments total), I^2C-bus controlled.

DISPLAY

64 segment LCD display.

SAA3010T

RC5 remote control transmitter (optional).

PCF8522E

256 byte EEPROM, for storage of audio and preset data, I^2C-bus controlled. (optional).

3. SHORT SPECIFICATION

Tuning

- Four bands FM, MW, LW and SW.

- Analog tuning principle with FLL backup system.

- Search up/down tuning with wrap around. Actual search is done by the TEA5757 IC, and the found frequency is read by the micro controller.

- Manual up/down tuning.

- Presets: 10 for FM and 5 for MW, LW, SW or FM-L (=FM Low in East Europe) and 3 for the Japanese TV band.

- Preset scan, pausing for 10 sec. on every station before selecting the next preset in that band.

- AST (Automatic Store Tuning), searches and stores the strongest 10 (FM) or 5 (FM, MW or SW) transmitters.

- Saving last band and frequency of station at power off. (When the set is in stand-by.)

CD functions

- Tray open/close.

- Play/Pause, starts the disc playing / pauses playing of the disc.

- Stop/Clear, stops the disc playing / clears program settings.

- Next/Previous track, system jumps to the next or previous track. Direct track access via 10 digit keys.

- Search Forward/Reverse, two speed search:
  - audio attenuated for low speed search;
  - audio muted for high speed search.

- Repeat, two repeat modes:
  - repeat current track;
  - repeat entire disc.

- A -> B repeat, repeats a user defined section of the disc.

- Random play, disc tracks played in a random sequence.

- Scan, scans the disc playing the first 10 seconds of each track in numerical order.

- Program/Review, allows programming of up to 15 tracks for sequential play.

- Time formats, four time display modes:
  - elapsed track time;
  - remaining track time;
  - elapsed time from start of disc;
  - remaining time to end of disc.

Sound control

- Volume up/down control by means of a motor controlled potentiometer.

- Volume, balance, bass and treble control by means of an I^2C-bus controlled audio processor or by means of potentiometers.

- Audio select key to select the audio function to control, (bass, treble, balance and volume), by means of the audio up/down keys.

- Four stereo source inputs: radio, CD, tape and auxiliary.

- Mute output to mute the power amplifiers, (via pin or I^{2}C-bus controlled audio processor).

- Saving last sound settings at power-off (stand-by mode).

Clock functions

- 12H/24H clock display function, also in stand-by mode.

- Switch on/off timer functions.

- Sleep timer function (90 -> 80 -> ... -> 10 -> off -> 90 min.).

Display

- LCD display, 32 x 2 segments.

- Icons:
  - INTRO, CD intro scan or preset scan;
  - REPEAT, CD repeat track or repeat disc;
  - RANDOM, CD random mode;
  - SLEEP, sleep timer enabled;
  - TIMER ON/OFF, timer on/off indication;
  - MEMORY, CD or preset programming mode, AST programming;
  - TRACK, CD track number;
  - FM, MW, LW, MHz, kHz, CH, used during radio mode;
  - AM, PM, clock indication;
  - STEREO, stereo mode in the FM band;
  - "5", display 5/50 kHz in the SW/FM band (East Europe FM-L band only).

- Two digits (7 segments) for CD track or preset number display.

- Four digits (7 segments) for frequency or time display.

Keys

- 36 local keys.

- RC5 remote control.

Tape deck

- Key to select tape mode.

- Automatic detection of play mode, switches over to tape mode when the play key of the tape mechanism is pressed.

- Interfaces with a mechanically controlled tape deck.

- CD synchro record mode, in CD mode the CD will start playing when the record key of the tape mechanism is pressed.

Auxiliary input

- Key to select auxiliary mode.

Switching on/off

- Momentarily on/off key.

- Continuous mains power supply, to be able to keep the RAM preset data (when no NVM is used), and clock functions.

- Recall of last mode (radio/CD/tape/auxiliary), in radio mode last band, preset and frequency, analogue sound settings when switching on from stand-by.

- Display of clock function in stand-by mode.

- First time power-on detection and defaults for presets, analogue sound settings and clock settings.

- Output to switch to power supply, using the timer functions.

Non Volatile Memory

Optional a 256 bytes NVM is installed to store the next information:

- 10 presets for each band.

- Last selected band, preset number and frequency.

- Audio controls: volume, balance, bass and treble.

- Selected source: radio, CD, tape or auxiliary.

- Status of the switch-on/off timers, enabled/disabled and the switch-on/off time.

Options

Diode programmable:

- Area and band, 4 diodes allowing 16 implementations.

- Various clock and timer functions.

- 12H/24H clock function.

- CD system to be used with a tray loader (L1210) or a top loader.

- 10 Digit preset or track select keys or preset up/down keys.

Automatic detected:

- RC5 remote control system.

- Electronic controlled audio processor TDA8424, detection by means of the I^2C-bus.

- Non Volatile Memory PCF8522E, detection by means of the I^2C-bus.

4.   MICROCONTROLLER AND PIN ASSIGNMENTS

CCA210S is based on a OM5234 mask programmed micro controller. The pin assignments for CCA210S are given in the figure below.
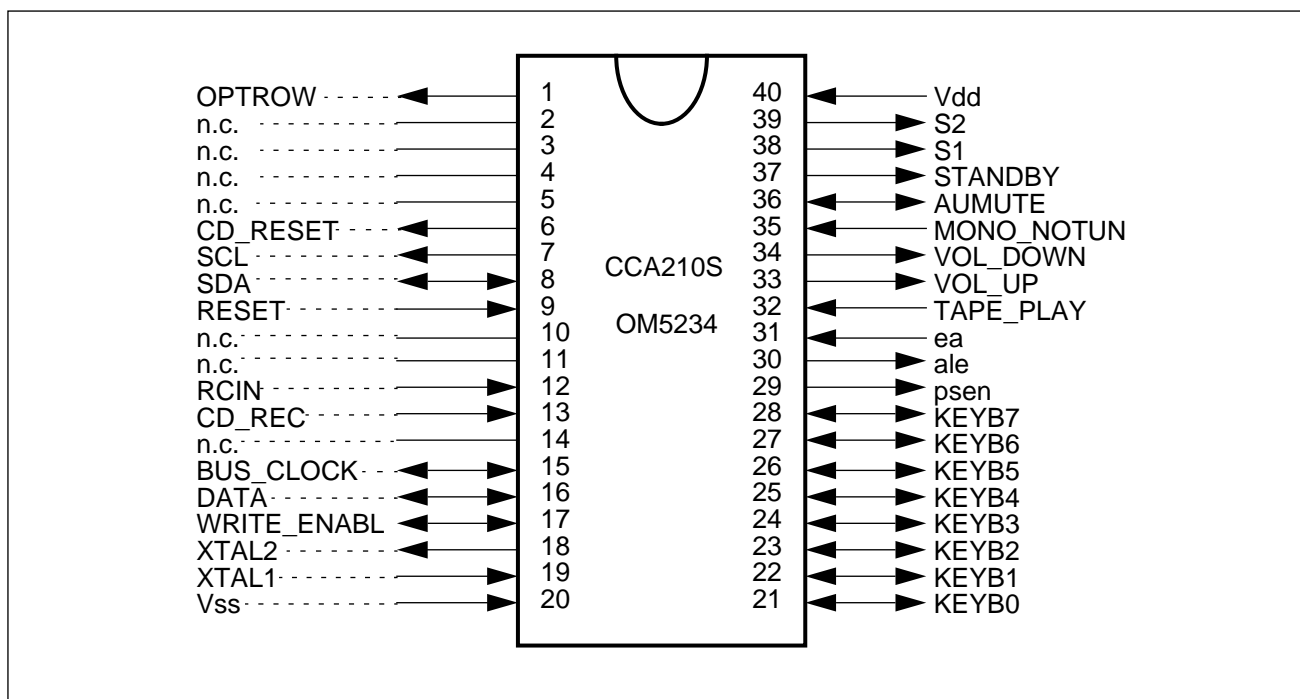
Fig.3 Pinning of CCA210S

The next table gives a description of all pins.

TABLE 1 Pinning

pin	name	I/O	description
1	OPTROW	O	Option row output. Connected to the cathodes off all option diodes.
2	n.c.		
3	n.c.		
4	n.c.		
5	n.c.		
6	CD_RESET	O	Reset for CD7
7	SCL	O	Clock line of I^2C-bus.
8	SDA	I/O	Data line of I^2C-bus.
9	reset	I	Micro controller reset pin
10	n.c.		
11	n.c.		
12	RCIN	I	Input from IR remote control receiver
13	CD_REC	I	CD record synchronisation
14	n.c.		

MICROCONTROLLER AND PIN ASSIGNMENTS

TABLE 1 Pinning

pin	name	I/O	description
15	BUS_CLOCK	I/O	Serial Clock output connected to the TEA5757, option diode D5 input.
16	DATA	I/O	Serial Data input/output connected to the TEA5757, option diode D7 input.
17	WRITE_ENABL	O	Write Enable output pin connected to the TEA5757, option diode D6 input.
18	xtal1	O	Oscillator output 12 MHz.
19	xtal2	I	Oscillator input 12 MHz.
20	Vss		Ground
21	KEYB0	I/O	Keyboard matrix line 0, option diode D0 input.
22	KEYB1	I/O	Keyboard matrix line 1, option diode D1 input.
23	KEYB2	I/O	Keyboard matrix line 2, option diode D2 input.
24	KEYB3	I/O	Keyboard matrix line 3, option diode D3 input.
25	KEYB4	I/O	Keyboard matrix line 4, option diode D4 input.
26	KEYB5	I/O	Keyboard matrix line 5.
27	KEYB6	I/O	Keyboard matrix line 6.
28	KEYB7	I/O	Keyboard matrix line 7.
29	/psen	O	Program store enable (n.c.)
30	ale	O	Address latch enable (n.c.)
31	/ea	I	External Access input (connect pull-up)
32	TAPE_PLAY	I	Tape play detection (auto source switching).
33	VOL_UP	O	Volume motor control up
34	VOL_DOWN	O	Volume motor control down
35	MONO_NOTUN	I	Stereo on in-tune detection input, to be connected to the TEA5757, option diode D8 input.
36	AUMUTE	O/I	General audio mute. CD service mode detection.
37	STANDBY	O	Power control pin
38	S1	O	Source selection pin, see also S2.
39	S2	O	S2,S1: 00 = tape, 01 = radio, 10 = CD, 11 = auxiliary.
40	Vdd		power supply +5 V.

5.   KEYBOARD

5.1   Local keyboard layout

The keyboard consists of a 8-line triangular matrix connected to the micro controller and having 36 keys. The figure below shows all local keys and a possible grouping.
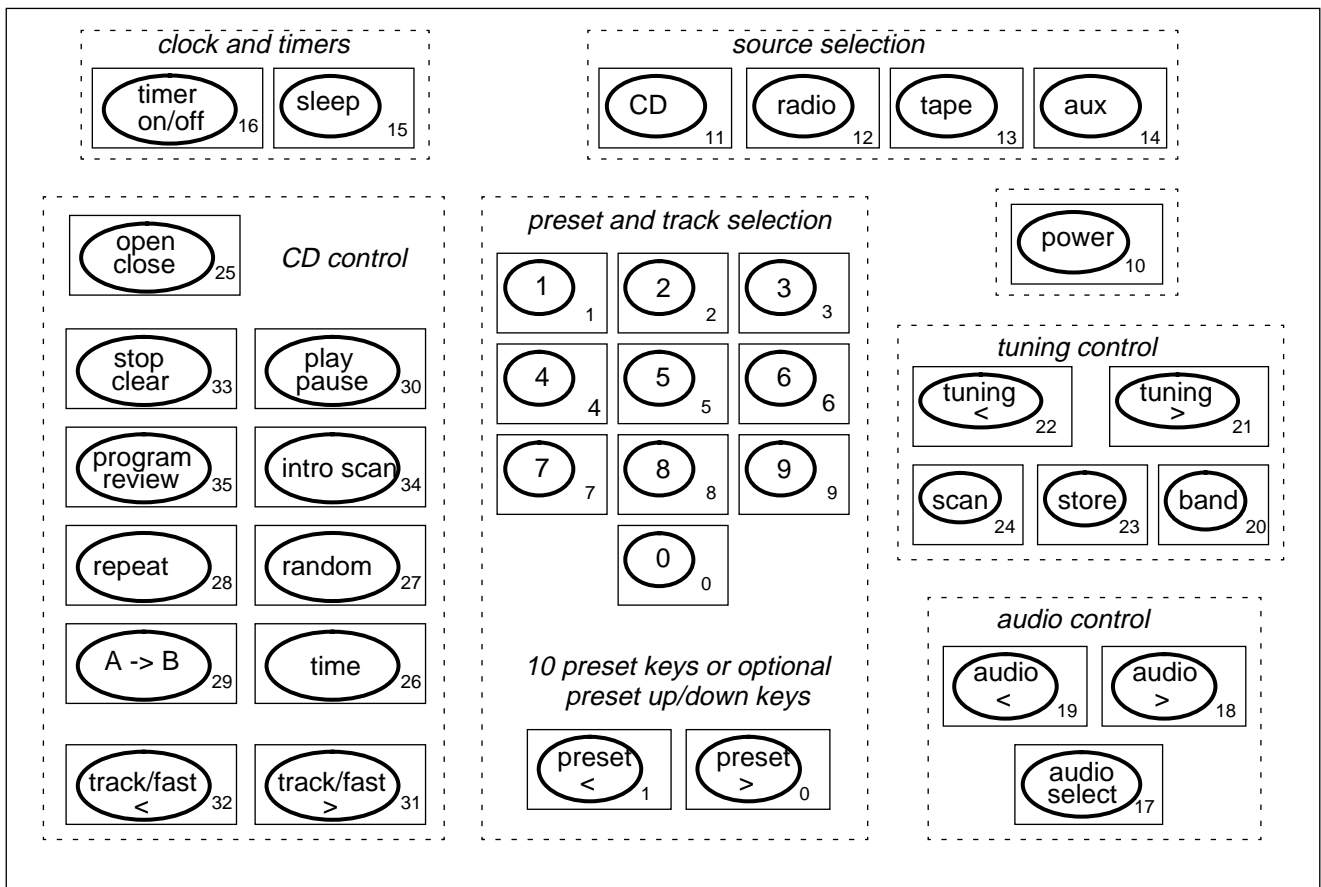
Fig.4 Local keys

5.2   Local key table

The following table shows the basic functions of the local keys in the various modes, CD/radio/tape/aux.

TABLE 2 Local keyboard

key	CD mode		radio mode		tape/aux mode	
0	digit 0	s[1]	preset 10	s	-	
	radio	s	preset up (optional)	r2	radio	s
1	digit 1	s	preset 1	2	-	
	radio[2]	s	preset down (optional)	r2	radio	s
2	digit 2	s	preset 2	s	-	
3	digit 3	s	preset 3	s	-	
4	digit 4	s	preset 4	s	-	

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TABLE 2 Local keyboard

key	CD mode		radio mode		tape/aux mode	
5	digit 5	s	preset 5	s	-	
6	digit 6	s	preset 6	s	-	
7	digit 7	s	preset 7	s	-	
8	digit 8	s	preset 8	s	-	
9	digit 9	s	preset 9	s	-	
10	power on/off	s	power on/off	s	power on/off	s
11	-		CD	s	CD	s
12	radio	s	-		radio	s
13	tape	s	tape	s	tape	s
14	aux	s	aux	s	aux	s
15	sleep timer	r2	sleep timer	r2	sleep timer	r2
16	timer on/off	s	timer on/off	s	timer on/off	s
17	audio select	s	audio select	s	audio select	s
18	audio up	r5	audio up	r5	audio up	r5
19	audio down	r5	audio down	r5	audio down	r5
20	radio	s	band	s	radio	s
21	radio	s	tuning up set minute (clock/timer)	r5,20 r5	radio set minute (clock/timer)	s r5
22	radio	s	tuning down set hour (clock/timer)	r5,20 r5	radio set hour (clock/timer)	s r5
23	radio	s	preset scan / AST	s	radio	s
24	-		preset store / set clock/timer	s	set clock/timer	s
25	open/close	s	open/close	s	open/close	s
26	time (track/CD time)	s	display (freq/clock/timer)	s	display (clock/timer)	s
27	random	s	CD/play[3]	s	CD/play	s
28	repeat	s	-		-	
29	A -> B	s	-		-	
30	play/pause	s	CD/play	s	CD/play	s
31	track/fast up	r2/ r5,20[4]	CD/play	s	CD/play	s
32	track/fast down	r2/ r5,20	CD/play	s	CD/play	s
33	stop/clear	s	-		-	
34	scan	s	CD/play	s	CD/play	s
35	program/review	s	-		-	

1. Repeat time explanations:
    s = single key command;
    rx = repeat rate of x times a second;
    r5,20 = repeat rate of 5 times second, after 2 seconds a repeat rate of 20 times a second.
2. "radio" means that the set switches from CD/tape/aux mode to radio mode.
3. "CD/play" means that the set switches from radio/tape/aux mode to CD mode and the CD starts playing.
4. Track/fast up/down with repeat rate r2/r5,20 means that the repeat rate for track up/down is r2, and for fast up/down a repeat rate of r5,20.

5.3 Remote key table

The following table shows the basic functions of the RC5 remote keys which are allowed.

TABLE 3 Remote Commands

RC5 code	system code[1]	CD mode		radio mode		tape/aux mode	
0	20	track 0	s	CD	s	CD	s
	17	radio preset 10	s	preset 10	s	radio preset 10	s
1	20	track 1[2]	s	CD	s	CD	s
	17	radio preset 1	s	preset 1	s	radio preset 1	s
2	20	track 2	s	CD	s	CD	s
	17	radio preset 2	s	preset 2	s	radio preset 2	s
3	20	track 3	s	CD	s	CD	s
	17	radio preset 3	s	preset 3	s	radio preset 3	s
4	20	track 4	s	CD	s	CD	s
	17	radio preset 4	s	preset 4	s	radio preset 4	s
5	20	track 5	s	CD	s	CD	s
	17	radio preset 5	s	preset 5	s	radio preset 5	s
6	20	track 6	s	CD	s	CD	s
	17	radio preset 6	s	preset 6	s	radio preset 6	s
7	20	track 7	s	CD	s	CD	s
	17	radio preset 7	s	preset 7	s	radio preset 7	s
8	20	track 8	s	CD	s	CD	s
	17	radio preset 8	s	preset 8	s	radio preset 8	s
9	20	track 9	s	CD	s	CD	s
	17	radio preset 9	s	preset 9	s	radio preset 9	s
12	16,17,18,20,21	power on/off	s	power on/off	s	power on/off	s
63	20	-		CD	s	CD	s
63	17	radio	s	-		radio	s
63	18	tape	s	tape	s	tape	s
63	21	aux	s	aux	s	aux	s
38	16,21	sleep timer	r2	sleep timer	r2	sleep timer	r2
16	16,17,18,20,21	volume up	r5	volume up	r5	volume up	r5
17	16,17,18,20,21	volume down	r5	volume down	r5	volume down	r5
22	16,17,18,20,21	bass up	r5	bass up	r5	bass up	r5
23	16,17,18,20,21	bass down	r5	bass down	r5	bass down	r5
24	16,17,18,20,21	treble up	r5	treble up	r5	treble up	r5
25	16,17,18,20,21	treble down	r5	treble down	r5	treble down	r5
26	16,17,18,20,21	balance right	r5	balance right	r5	balance right	r5
27	16,17,18,20,21	balance left	r5	balance left	r5	balance left	r5
30	17	radio	s	tuning up	r5,20	radio	s
31	17	radio	s	tuning down	r5,20	radio	s
32	17	radio	s	preset up	r2	radio	s
33	17	radio	s	preset down	r2	radio	s
45	20	open/close	s	open/close	s	open/close	s

KEYBOARD

TABLE 3 Remote Commands

RC5 code	system code[1]	CD mode		radio mode		tape/aux mode	
11	20	time (track/CD time)	s	-		-	
28	20	random	s	CD/play	s	CD/play	s
29	20	repeat	s	-		-	
59	20	A -> B	s	-		-	
53	20	play/pause	s	CD/play	s	CD/play	s
48	20	pause	s	-		-	
32	20	track/fast up	r2/ r5,20	CD/play	s	CD/play	s
33	20	track/fast down	r2/ r5,20	CD/play	s	CD/play	s
52	20	fast up	r5,20	-		-	
50	20	fast down	r5,20	-		-	
54	20	stop/clear	s	-		-	
43	20	scan	s	CD/play	s	CD/play	s
36	20	program/review	s	-		-	
15	20	review	s	-		-	

1. Definition of system codes: 16 = pre-amplifier; 17 = tuner; 18 = tape; 20 = CD; 21 = aux.
2. The set will stay in CD mode and select track 1 when the RC5 key code 1 is received together with system code 20. If however the system code 17 is received, the set will switch to radio mode and select preset 1.

OPTION DIODES

6. OPTION DIODES

The option diodes are connected to the keyboard and the STR pins.

TABLE 4 Option diodes

Option Diode	Option
D0	10 digit keys to select preset/track number directly or preset up/down keys. Diode is set: 10 digit select keys; Diode is not set: preset up/down keys.
D1	CD tray or top loader option. Diode is set: tray loader; Diode is not set: top loader.
D3 D2	Clock and timer enable/disable: 0 0[1] = no clock and no timer; 0 1 = clock function only; 1 0 = clock and timer-on function; 1 1 = clock and timer-on/off function.
D4	Select 12/24 hour type of clock. Diode is set: 24 hour clock; Diode is not set: 12 hour clock. The 12/24 hour option can be chosen when the clock/timer function is available. Below is shown how the clock and timer settings are displayed: 12 hour option: 24 hour option: 0:00 - 11:59 AM 0:00 - 11:59 12:00 - 12:59 PM 12:00 - 12:59 1:00 - 11:59 PM 13:00 - 23:59
D8 D7 D6 D5	Area options, see the frequency table.

1.   0= diode is not preset. 1= diode is present.

The next table shows the various frequency band options.

TABLE 5 Frequency band options

area	option code D8D7D6D5	presets[1]	band	start frequency	end frequency	step size	IF
Europe	0 0 0 0	10 5	FM MW	87.5 MHz 522 kHz	108 MHz 1620 kHz	100 kHz 9 kHz	10.7 MHz 450 kHz
Europe + LW	0 0 0 1	10/5 5	FM/MW + LW	153 kHz	279 kHz	3 kHz	450 kHz
Europe + SW-B	0 0 1 0	10/5 5	FM/MW + SW-B	2.3 MHz	21.75 MHz	5 kHz	450 kHz

OPTION DIODES

TABLE 5 Frequency band options

area	option code D8D7D6D5	presets[1]	band	start frequency	end frequency	step size	IF
Europe + LW, SW-A	0 0 1 1	5/5 5 5	FM/MW + LW SW-A	 153 kHz 5.9 MHz	 279 kHz 17.9 MHz	 3 kHz 5 kHz	 450 kHz 450 kHz
USA	0 1 0 0	10 5	FM MW	87.5 MHz 520 kHz	108 MHz 1710 kHz	100 kHz 10 kHz	10.7 MHz 450 kHz
Latin America	0 1 0 1	10 5	FM MW	87.5 MHz 520 kHz	108 MHz 1710 kHz	100 kHz 5 kHz	10.7 MHz 450 kHz
Latin America + SW-A	0 1 1 0	10/5 5	FM/MW + SW-A	 5.9 MHz	 17.9 MHz	 5 kHz	 450 kHz
Latin America + SW-B	0 1 1 1	10/5 5	FM/MW + SW-B	 2.3 MHz	 21.75 MHz	 5 kHz	 450 kHz
Near, Middle & Far East	1 0 0 0	10 5	FM MW	87.5 MHz 531 kHz	108 MHz 1719 kHz	100 kHz 9 kHz	10.7 MHz 450 kHz
Near, Middle & Far East + SW-A	1 0 0 1	10/5 5	FM/MW + SW-A	 5.9 MHz	 17.9 MHz	 5 kHz	 450 kHz
Near, Middle & Far East + SW-B	1 0 1 0	10/5 5	FM/MW + SW-B	 2.3 MHz	 21.75 MHz	 5 kHz	 450 kHz
East Europe	1 0 1 1	10 5 5	FM MW FM L	87.5 MHz 522 kHz 64 MHz	108 MHz 1620 kHz 74 MHz	100 kHz 9 kHz 50 kHz	10.7 MHz 450 kHz 10.7 MHz
South Africa	1 1 0 0	10 5	FM MW	87.5 MHz 531 kHz	108 MHz 1602 kHz	100 kHz 9 kHz	-10.7 MHz 450 kHz
Japan	1 1 0 1	10 5 3	FM MW TV[2]	76 MHz 522 kHz Ch1, 2, 3	91 MHz 1629 kHz	100 kHz 9 kHz	-10.7 MHz 450 kHz -10.7 MHz
FM only	1 1 1 0	10	FM	87.5 MHz	108 MHz	100 kHz	10.7 MHz

1. 10 presets are available for each band, (with exception of the Japanese TV band), when the NVM is installed.
2. The Japanese TV band covers the sound of the TV channels Ch1 (=95.75 MHz), Ch2 (=101.75 MHz) and Ch3 (= 107.75 MHz). These are fixed into preset 1, 2 and 3, and can not be changed by the user. When the Japanese TV band is chosen only preset selection is allowed.

The table below shows how the SW bands are divided in the various sub-bands.

TABLE 6 SW Frequencies

SW-A	SW-B	
5.900 - 6.200 7.100 - 7.350 9.400 - 9.900 11.600 - 12.100 13.570 - 13.870 15.100 - 15.800 17.480 - 17.900	2.300 - 2.495 3.200 - 3.400 3.900 - 4.000 4.750 - 5.060 5.900 - 6.200	7.100 - 7.350 9.400 - 9.900 11.600 - 12.100 13.570 - 13.870 15.100 - 15.800 17.480 - 17.900 18.900 - 19.020 21.450 - 21.750

7. LCD DISPLAY

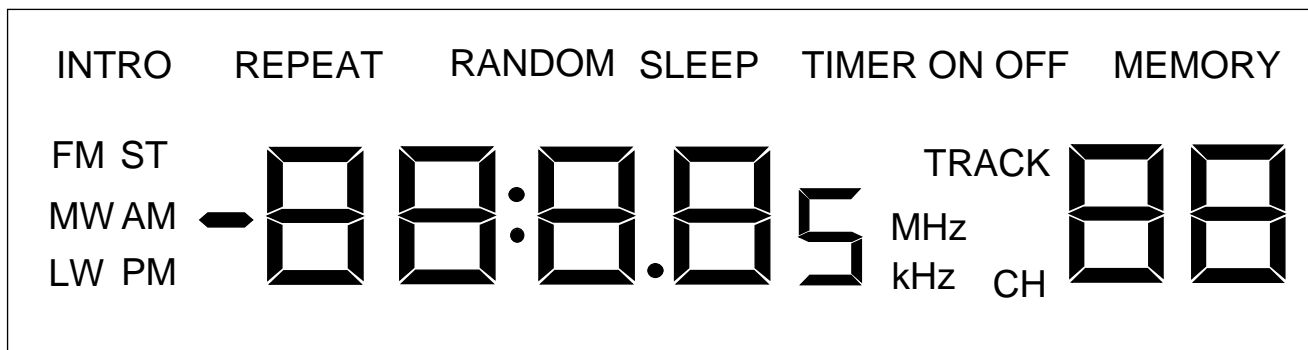The Liquid Crystal Display (LCD) is driven by one PCF8577CT. In the figure below the used display is shown.

Fig.5 LCD display layout