

APPLICATION NOTE

**Outline Specification of
High-End RDS/EON Car Radio
System CCR520S (V2.6)**

AN96022

**Outline Specification of High-End RDS/EON
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Abstract

CCR520 is a computer controlled high-end AM/FM car radio system with RDS/RBDS decoding. It is based on a single 8051 family microcontroller (P83CE528) and various I²C-bus controlled peripherals.

The system contains functions such as PLL tuning, IF control, stereo decoding, RDS/RBDS+EON decoding, IAC, sound switching, sound fader control, LCD display, cassette interface, external audio input jack, clock function, infra red remote control and a detachable front.

Radio control and RDS/RBDS+EON processing are combined in a single microcontroller.

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Outline Specification of High-End RDS/EON Car Radio System CCR520S (V2.6)

AN96022

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Summary

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The system contains functions such as PLL tuning, IF control, stereo decoding, RDS/RBDS+EON decoding, IAC, sound switching, sound fader control, LCD display, cassette interface, external audio input jack, clock function, infra red remote control and a detachable front.

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Document history

Modifications with respect to the application note "Outline Specification of Computer Controlled Car Radio System CCR520S V2.5", report number AN96007 :

1. Added infra red RC5 remote control.

Modifications with respect to the application note "Outline Specification of Computer Controlled Car Radio System CCR520S V2.0", report number AN95033 :

1. NVM Initialization added.
2. Clock with synchronisation to RDS added
3. Sleep timer changed from 30 minutes to 1 hour.

Modifications with respect to the application note "Outline Specification of Computer Controlled Car Radio System CCR520S V1.5", report number ERA/AN93008 :

1. USA option added for RBDS and USA band limits / tuning grid.
2. Allow AF-switching to Supra-regional transmitters for RDS.
3. PTY functionality.
4. During AST running frequency is not displayed any more.
5. The TA / PTY Alarm volume level is programmable.
6. Improved RDS decoding and AF switching behaviour especially with respect to multipath.
7. Improved EON preset update.

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1 INTRODUCTION

CCR520S is a computer controlled system based on a P83CE528 microcontroller. It controls a high-end AM/FM car radio with RDS (Radio Data System) or RBDS (Radio Broadcast Data System) and EON (Enhanced Other Networks information) and various I²C-bus controlled peripherals.

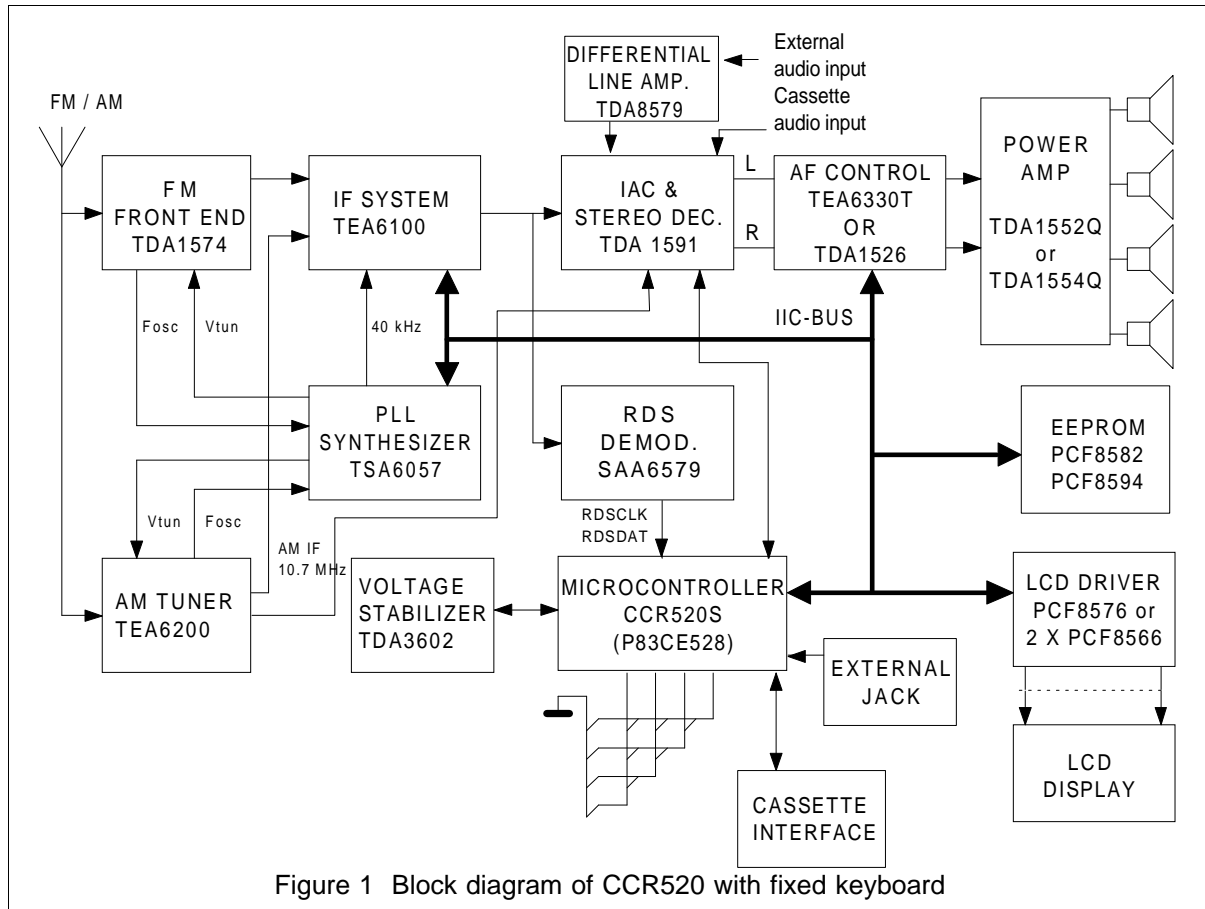
The main features are:

- Radio control and RDS/RBDS decoding in a single microcontroller.
- Bands: FM, MW, LW. (Factory options: FM only / LW disable)
- Tuning: manual, automatic (search and scan), Automatic Store Tuning (AST), options: tuning grid and band limits for different parts of the world (Europe/USA option).
- Presets: 18 FM, 12 MW, 6 LW.
- External audio jack for e.g. CD player.
- Controls power stabilizer IC.
- PLL frequency synthesizer.
- Sound control: volume, bass, treble, balance, fader, loudness and mute via I²C-bus or potentiometers.
- RDS/RBDS functions:
 - PS: Programme Service name display and storage in Non Volatile Memory;
 - PTY: Programme TYpe display and searching;
 - TP/TA: Traffic Announcements break-in;
 - AF/PI: Alternative Frequency follow and storage in Non Volatile Memory;
 - EON: Enhanced Other Networks traffic announcements and update of preset AF lists in NVM.
 - CT: Clock-time information extraction for clock function.
- Security code:
 - enable/disable by the user;
 - preprogrammable in the factory by means of a service mode.
- Non Volatile Memory for:
 - programme presets;
 - RDS/RBDS information;
 - System status.
- LCD display with 120 or 144 segments.
- Keyboard optionally detachable with up to 27 key functions.
- Remote control
- Clock function

NOTE: RBDS is an extension of the European RDS system. Every reference in this document to RDS is also valid for the RBDS system, unless specified otherwise.

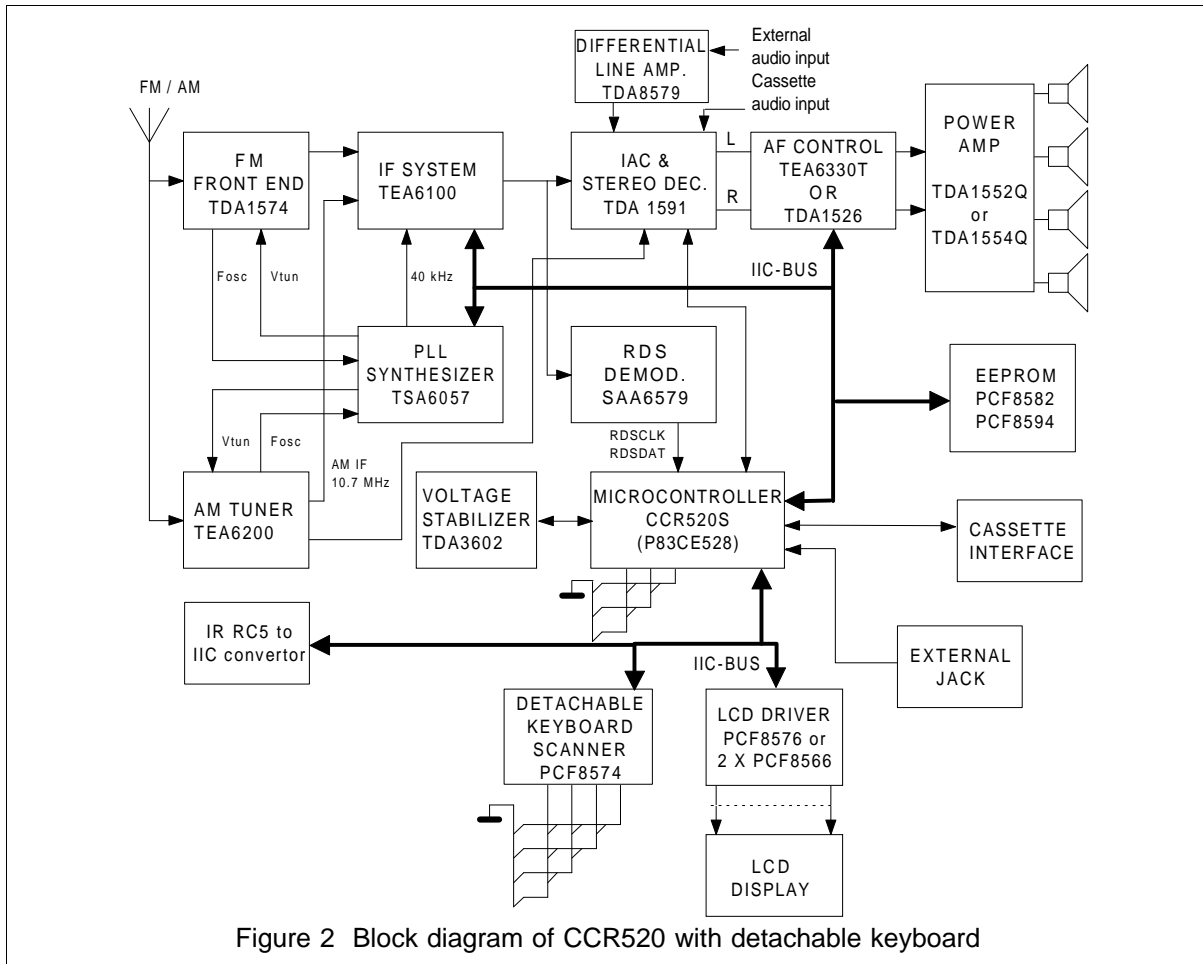
2 BASIC HARDWARE CONFIGURATION

The basic configuration of the computer controlled car radio system CCR520 is given in the figures below.



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The CCR520 concept requires the next IC's to be present in the system:

- TDA1574(T) Performs all the FM front-end functions, except the R.F. pre-amplifier stage. Incorporates an FM/IF pre-amplifier.
- TEA6200 AM tuner, up-conversion system. Does not need an aerial tuned circuit. I.F. frequency 10.7 MHz. No alignments needed.
- TEA6100 Integrated FM/IF system including a digital AM/FM tuning interface for microcomputer controlled radios with an I²C-bus.
- TSA6057(T) PLL synthesizer with separate prescalers for AM and FM and loop filter outputs. I²C-bus controlled.
- TDA1591(T) System combination of adjustment free PLL stereo decoder with de-emphasis control and an Interference Absorption Circuit (IAC) with low component count. Specially designed for car radios.
- TEA6330T or TDA1526 I²C-bus (TEA6330) or potentiometer (TDA1526) controlled AF pre-amplifier for car and home receivers. Includes volume, bass, treble, balance, fader (TEA6330) control and mute (TEA6330).
- CCR520S The microcontroller, based on a P83CE528EFB. It is a 8051 derivative with an 8-bit CPU, 32 Kbytes ROM, 512 bytes RAM and four 8-bits I/O ports in a 44-pin QFP package.
- TDA3602 Supply voltage stabilizer in SIL package with three output voltages (2 x 5V and 8.5V). Two outputs are switchable by external controls.
- TDA1552Q TDA1554Q Class-B audio power amplifiers in SIL plastic package with 4 identical amplifiers. The TDA1552Q can deliver 2 x 22 W in BTL configuration, the TDA1554Q can deliver either 4 x 11 W or 2 X 22 W.
- SAA6579(T) RDS demodulator with onboard 57 kHz bandpass filter and a digital demodulator. Outputs a digital data signal and a clock signal for further processing.
- PCF8566T PCF8576CT LCD display drivers that interface to almost any liquid crystal display (LCD) having low multiplex rates. They generate the drive signals for any static or multiplexed LCD with up to four backplanes and up to 24 (PCF8566) or 40 (PCF8676) segment lines and can easily be cascaded for larger LCD applications. I²C-bus controlled.
- PCF8582/94C-2P/T 256/512 byte 5V electrically erasable programmable read only memories (EEPROM) that can be 100,000 times re-written.
- PCF8574(T) Detachable Keyboard Scanner. I²C-bus controlled.
- TDA8579(T) Differential Line Amplifier for external input.
- 84C21A Programmed with RC5 to I²C convertor software.

3 SHORT SPECIFICATION

Tuning

- Frequency bands

Optionally the following frequency bands are used:

| | | | | |
|-----------|---|---------------------------------|---|---------------------------|
| FM: 87.50 | - | 108.00 MHz (50 / 100 kHz steps) | } | |
| MW: 531 | - | 1629 kHz (1 / 9 kHz steps) | } | For application in Europe |
| LW: 144 | - | 288 kHz (1 kHz steps) | } | |
| | | | | |
| FM: 87.90 | - | 107.90 MHz (50 / 100 kHz steps) | } | For application in USA |
| AM: 530 | - | 1710 kHz (1 / 10 kHz steps) | } | |

- PLL tuning principle.
- Manual tuning up / down.
Initially slow pace / fine grid. After 2.5 sec. fast pace / coarse grid.
- Local/DX switch.
The local/DX feature controls the search sensitivity. If the FM tuner has a tuner attenuator, the local/DX switch controls the attenuator during search. If not, it controls the signal level threshold during search. Default after switching on is always DX mode.
- Automatic search tuning up / down.
Sensitivity is controlled by local/DX. If after one complete band sweep in local mode no station is found, the radio switches automatically to DX. Automatic muting and display of running frequency.
- Frequency scan.
Continuous automatic search tuning, pausing for 6 seconds on every station.
- AST (Automatic Store Tuning) for FM and MW band.
AST switches to FM-AST or MW-AST band, searches for the 6 strongest transmitters and stores them in the AST programme preset memory. In FM, duplication of PI codes will be avoided.
- Programme preset memory.
For each band (FM1, FM2, MW, LW, FM-AST and MW-AST) 6 programme presets and a "manual" frequency are stored. In FM, additional RDS information is stored: PI code (Programme Identification), PS-name (Programme Service), AF list (Alternative Frequencies) and AF follow mode on/off.
Whenever another band is selected, the radio reverts to the last frequency tuned to in the new band. (This can be either a preset frequency or a manually tuned frequency).
- Programme preset up / down control.
Programme presets can be recalled/stored by two key control (up and down) or by 6 separate preset keys.

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- AF follow mode.
If AF follow mode is on, the set will regularly measure the signal strength on alternative frequencies and compare it with the current station. If an alternative frequency offers better quality, the radio will switch over, and update the alternative frequency list. The measuring scheme is designed to cause minimum noticeable disturbance for the listener. The interval time between two measurements depends on the signal quality.
- Intelligent preset programme recall.
If an FM programme preset with a known PI code is recalled, the primary frequency and all alternative frequencies stored in NVM are examined. The frequency with the highest signal strength that broadcasts the correct PI code will be selected. Only when the programme is not found on one of the AFs, a search is started after 6 seconds for a station with the proper PI code.
- TA mode.
In TA mode the radio only searches for traffic stations. These are stations that may transmit (EON) traffic announcements.
The radio will automatically start a search when switching TA mode on and the current station is not a traffic station.
- PTY search mode.
In PTY search mode the radio only searches for transmitters that transmit a user-selected PTY code. Dependent on the factory option USA/Europe the RBDS PTY-table or the RDS PTY-table is used.
- Last status memory: frequency, PI code, PS Name, AF lists and AF follow mode on/off status are stored in memory for each preset in each band. This status is recalled during preset switch, band switch and switch on.

RDS

- Bit, block and group synchronisation (inclusive RBDS E-block detection).
- Data decoding and collection of:
 - PI, Programme Identification code;
 - AF, Alternative Frequencies;
 - TP, Traffic Programme;
 - TA, Traffic Announcement;
 - PS, Programme Service name;
 - PTY, Programme TYpe;
 - EON, Enhanced Other Networks information;
 - CT, Clock-time information.
- AF follow mode using PI and AF (see also Tuning).
- Display of the Programme Service name in 8 alpha-numeric characters (PS name).
- Display of AF, TP, TA, PTY and regional mode status.

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- Regional mode on/off switching. When regional mode is on, the radio will, during AF switching, only switch over to stations with exactly the same PI-code or Supra-regional code. When regional mode is off, the radio will also switch over to stations broadcasting regional variants of the original PI-code. (so called "generic" or "family" PI-codes). For USA application (RBDS) the regional function will only work for PI codes above B000_{hex}. PI codes below B000_{hex} don't have regional variants. (AF-switching is only allowed to stations with exactly the same PI code).
- Break-in of traffic announcements and PTY alarm messages when the radio is muted or in Cassette / External mode.

EON

- Temporally switch to an other station if EON information indicates a traffic announcement on that other station even when the radio is muted or in Cassette / External mode.
- Update lists of alternative frequencies of other stations stored in preset memory with information received via EON.

Control


- Up to 27 local control keys on either a fixed, a detachable keyboard or a combination.
- Detachable front
Optionally, the keyboard and the LCD display unit can be placed on a detachable front, controlled by a 2nd I²C bus. Only 5 contacts are required to connect the detachable front (6 if it hosts also the power key). No extra hardware is required to detect its presence.
- Remote control
A remote control unit can be added in case a detachable keyboard is used. Several functions can be controlled from the remote control. The remote control hardware is connected with the detachable keyboard I²C bus.

Display

- 120 Segment LCD or 144 Segment LCD with Umlaut (ü) and Accent (á) characters, 1:3 multiplexed.
- 8 Alphanumeric characters + decimal point are used for display of:
 - Band and frequency (Example: "FM 103.50")
 - Indication "BALANCE", "FADER", "TREBLE", "BASS" and their position (either analog bar or digital)
 - The security code being entered
 - RDS programme service name (PS) in 8 alphanumeric characters
 - RDS programme type (PTY)
 - "MUTE", in case the user mutes the radio, cassette or external
 - Cassette mode function such as "PLAY ->", "CAS WIND", etc.
 - Clock display can be: " 08.12" or " --.--" if not yet synchronised to RDS clock.

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- 7 Segment display for the current programme preset number.

- 8 Icons for display of:
 - STEREO On when stereo pilot signal is detected, off when forced mono is selected or no stereo pilot signal is detected.
 - AST On when AST band selected.
 - AF On when AF follow mode is enabled (see also Tuning). Flashes if no RDS data received.
 - TA On in TA mode and flashing during a traffic announcement in progress.
 - TP On when a traffic station is received, flashing when the station is not a traffic station and TA mode is on.
 - PTY On when PTY code received, flashing during PTY search.
 - DOLBY  On in cassette mode when dolby selected.
 - ME/CR On in cassette mode when ME/CR selected.

Non Volatile Memory

Either 256 or 512 bytes. The amount of memory determines the maximum number of alternative frequencies to be stored per preset (5/9 AF's for 256/512 bytes EEPROM).

The following information is stored in NVM:

- Checksum to verify whether an EEPROM has been initialized or not. If a not initialized EEPROM has been detected default values will be stored to insure reasonable settings for e.g. the audio control values.
- System status e.g.: band, audio source (radio / cassette / external).
- User programmable options.
- For each band (FM1, FM2, FM-AST, MW1, MW-AST, LW): six preset frequencies and one non-preset frequency, last used preset.
- For each stored FM frequency:
 - PI-code
 - PS Name (512 byte EEPROM only)
 - AF List (9 AF's maximum, 5 AF's for 256 byte EEPROM)
 - AF follow mode on/off.
- Audio controls: volume, bass, treble, fader, balance and loudness.
- Four digit security code (0000 - 9999).
 - Security code can be preprogrammed with the keyboard by means of a service mode, or a preprogrammed EEPROM has to be used.
 - Security code can not be changed by the user. The security code can be enabled or disabled by the user; enable/disable status is stored in NVM.
 - If enabled, the security code must be entered each time the main supply line has been interrupted or the radio has been removed from the retrack.

External audio input

- Automatically switches to external audio source when a connector is inserted.
- External/radio mode key.
- Optional source switching to cassette mode (cassette is in) or always to radio mode (option diode D6 is in) when the external plug is removed.

Sound

- Volume, balance, fader, treble and bass control with vol-up/down keys.
- Analog control select key to cycle through balance, fader, treble and bass.
- Mute key
- Automatic muting during tuning and AST search (silent tuning).
- Break-in of traffic announcements (in TA mode) and PTY-alarm messages when the radio is muted or in cassette / external mode. The volume level during a TA / PTY message can be installed to one of 5 fixed by means of the user programmable options.
- Loudness switching.
- Sound settings are stored at switch-off and recalled at switch-on.
- "Bleep" tone to confirm user actions such as storing a programme preset, entering AST mode, etc.
- Mono / stereo function.
- Output pins for mute, loudness and traffic announcement, for use with conventional audio control circuitry.

Power-amplifier

- Conventional power-amplifiers can be used such as two TDA1552Q (4 x 22 Watt), one TDA1554Q (4 x 11 Watt (2 Ω load) or 6 Watt (4 Ω load)) or one TDA1552Q (2 x 22 Watt (4 Ω load)) in a BTL stereo configuration.

Options

- Diode programmable
 - Detachable front
 - No LW band
 - FM only
 - No security code
 - Static on/off switch
 - Method of source switching
 - Application area of the radio (USA/Europe)

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- User programmable
 - 2 / 4 Loudspeakers
 - Loudness on/off
 - Bar / digital sound control display
 - TA / PTY Alarm volume level
 - Security code enable/disable

- Automatically detected
 - Digital sound control chip or conventional controls
 - 120 / 144 segment LCD display
 - 256 or 512 bytes EEPROM
 - Loudness
 - Local/DX FM Tuner Control
 - AMS ()
 - Dolby () Cassette deck functions
 - ME/CR ()

- Remote control unit.

Power connections

- Continuous power supply input. Normally connected directly to the car battery. All supply power is drawn from this input.
- Ignition key input. Normally connected to the accessory contact of the ignition switch. Used for switching the radio on/off by the ignition key. This input is also used when the static on/off switch option is chosen instead of the momentary on/off key. In this case the static on/off switch button is connected to the ignition key input.

Switching-on/off

- Recall of last system status (e.g.: frequency, band, sound control settings, RDS status and last selected audio source).
- Switch on by:
 - Power key, can be static or momentary.
 - Ignition contact (after the set was switched off by turning the ignition off).
- Switch off by:
 - Power key, can be static or momentary.
 - Ignition contact.
 - Removal of detachable keyboard.
 - Opening of the security contact.
 - Wrong security code entered (after 30 to 40 seconds).
 - When switched on while the ignition contact is (and remains) off, the set will automatically switch off after 60 minutes.
 - The radio will switch on again when switched off due to a power dip during engine start.

Cassette

- Automatically switches to cassette mode after insertion of a cassette
- Interfaces with a mechanically controlled cassette deck
- Play/wind mode detection
- Play direction detection for auto-reverse cassette decks
- Radio reception during wind mode
- Cassette/Radio mode key
- Metal/Chromium tape on/off key
- DOLBY system on/off key
- AMS (Auto Music Search) on/off key
- Optional source switching to external mode (cd plug is in) or always to radio mode (option diode D6 is in) when the cassette is ejected.

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4 TARGET CHARACTERISTICS OF THE RADIO

General

| | | | | | |
|-------------------------------|-----------|------|----|-------|-----------|
| Supply voltage range | | 10.2 | to | 16 | V |
| Quiescent current, | power off | | | 2 | mA (typ.) |
| | power on | | | 520 | mA (typ.) |
| Operating ambient temperature | | -30 | to | 75 | °C |
| FM frequency range | Europe | 87.5 | to | 108 | MHz |
| | USA | 87.9 | to | 107.9 | MHz |
| AM frequency range | Europe | 144 | to | 288 | kHz (LW) |
| | | 531 | to | 1629 | kHz (MW) |
| | USA | 530 | to | 1710 | kHz (MW) |
| IF-frequency (AM and FM) | | | | 10.7 | MHz |

FM characteristics

$V_{supply} = 14.4 V,$
 $T_{amb} = 25 °C,$
 $f_o = 98 MHz,$
 $f_{dev} = 22.5 kHz,$
 $f_{mod} = 1 kHz$ unless otherwise specified.
 Dummy aerial as shown in Figure 3.

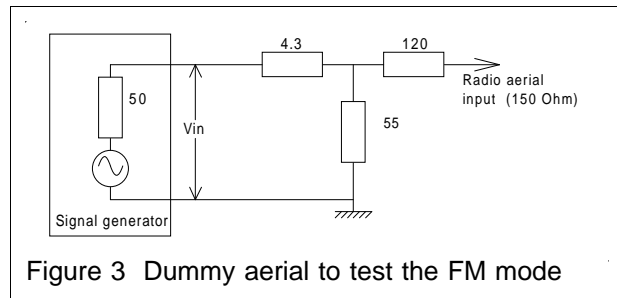


Figure 3 Dummy aerial to test the FM mode

| | | |
|---|------|----------|
| Aerial input voltage (V_{in}), for -3 dB limiting ($f_{mod} = 400Hz$) | 10 | μV |
| for $(S+N)/N = 26 dB$ | 3 | μV |
| for 10 dB crosstalk (stereo) | 150 | μV |
| Signal-to-noise ratio over most of the signal range | 60 | dB |
| RF signal handling capability for THD < 2% at 75kHz dev. | > 2 | V |
| AF output over most of the signal range measured at pin 11 of IF module TEA6100. | 150 | mV |
| AM suppression over most of the signal range | > 50 | dB |
| Total Harmonic Distortion over most of the signal range. 75 kHz dev. | 0.5 | % (typ.) |
| Adjacent signal selectivity (two signal method) S_{200} | > 44 | dB |
| IF bandwidth 3dB bandwidth | 160 | kHz |
| IF suppression | > 85 | dB |

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|-----------------------|----------------------|-----|---|-----|-----|
| Search sensitivity | | Vin | > | 20 | μV |
| RDS sensitivity: | Traffic Announcement | Vin | > | 14 | μV |
| | PService Name | Vin | > | 16 | μV |
| IF counter resolution | | | | 6.4 | kHz |
| Frequency grid | Search Tuning | | | 100 | kHz |
| | Manual Tuning | | | 50 | kHz |

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AM characteristics

$V_{supply} = 14.4\text{ V}$,
 $T_{amb} = 25\text{ }^{\circ}\text{C}$,
 $f_o = 999\text{ kHz}$,
 $m = 0.3$,
 $f_{mod} = 1\text{ kHz}$ unless otherwise specified.
 Dummy aerial as shown in Figure 4.

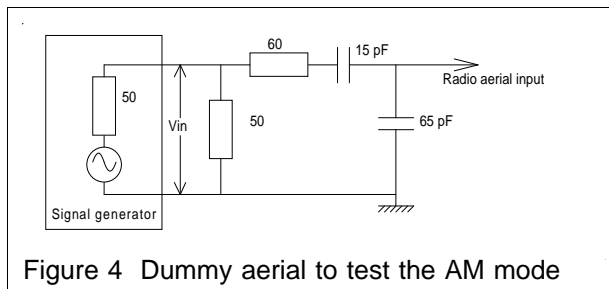


Figure 4 Dummy aerial to test the AM mode

| | | | |
|--|----------|-----------|---------------|
| Aerial input voltage (V_{in}), for $(S+N)/N = 26\text{ dB}$ | MW | 45 | μV |
| | LW | 70 | μV |
| Signal-to-noise ratio for $V_{in} = 1\text{ mV}$ | | > 45 | dB |
| AGC range $V_{in}/500\text{ mW}$ for 10 dB variation of AF output | | 90 | dB |
| RF signal handling capability for THD < 10 % at $m = 0.8$ | | 1.4 | V |
| Total Harmonic Distortion over most of the AGC range, $m = 0.8$, $f_{mod} = 400\text{ Hz}$ | | < 2 | % |
| Total bandwidth B 3dB | | 5 | kHz |
| Fidelity (-3 dB) | | 30 Hz - 2 | kHz |
| IF suppression tuned frequency 1400 kHz, $V_{in} = 20\text{ }\mu\text{V}$ | | 62 | dB |
| Image rejection tuned frequency 1400 kHz, $V_{in} = 20\text{ }\mu\text{V}$ | | 76 | dB |
| IF selectivity | S_9 | 36 | dB |
| | S_{20} | 66 | dB |
| IF counter resolution | | 500 | Hz |
| Frequency grid, | | | |
| LW (search and manual tuning) | | 1 | kHz |
| MW (search tuning) | Europe | 9 | kHz |
| MW (manual tuning) | | 1 | kHz |
| MW (search tuning) | USA | 10 | kHz |
| MW (manual tuning) | | 1 | kHz |
| Search sensitivity | V_{in} | > 40 | μV |

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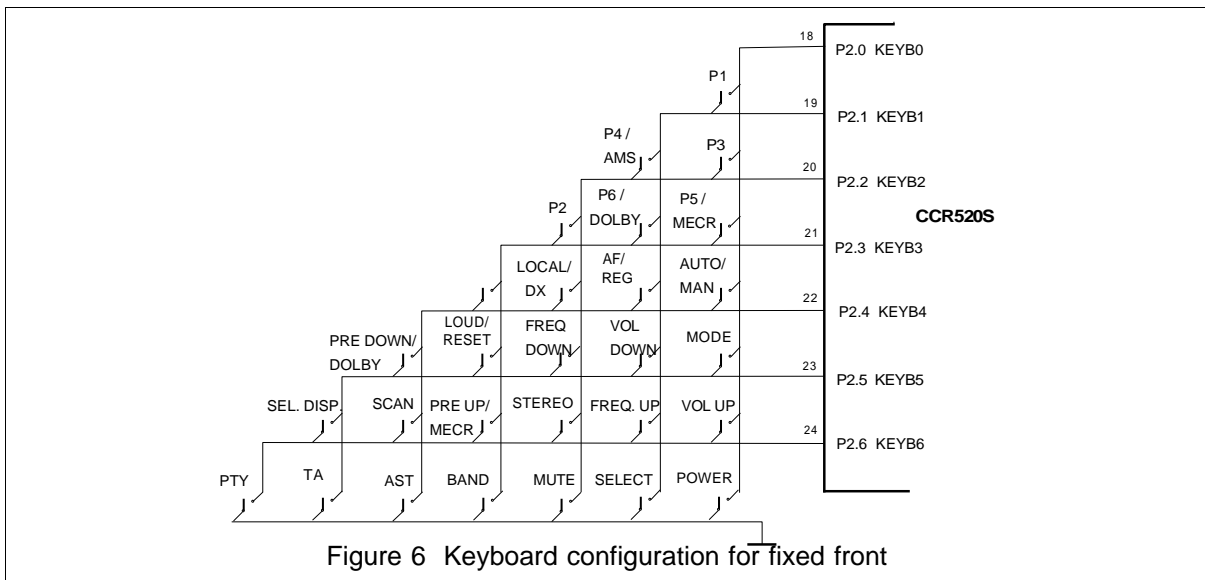
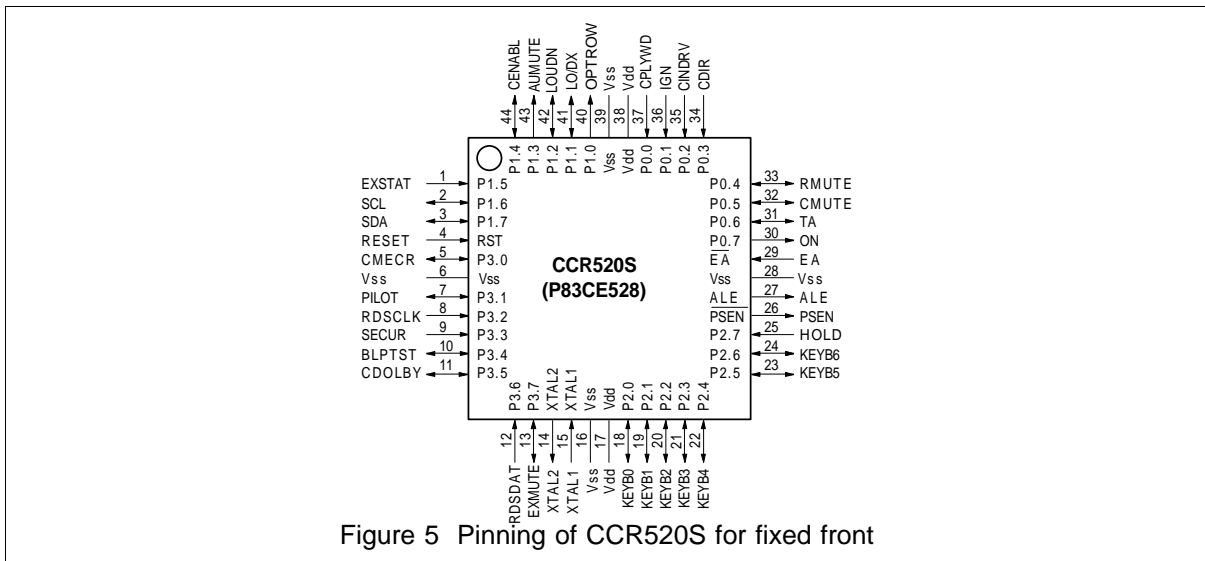
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5 MICROCONTROLLER AND PIN ASSIGNMENTS

CCR520S is based on a P83CE528 microcontroller. It is single-chip microcontroller, manufactured in an advanced CMOS process and is a derivative of the 80C51 microcontroller family.

The pin assignments for CCR520S are given in Figure 5 and Figure 7.

Figure 6 and Figure 8 show the keyboard configurations for the fixed and detachable front respectively.



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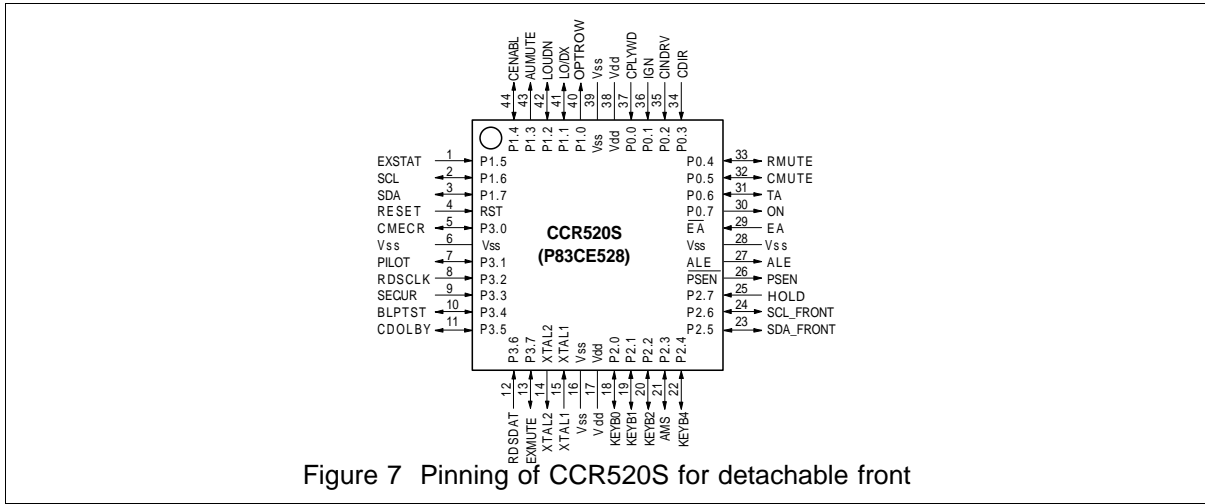


Figure 7 Pinning of CCR520S for detachable front

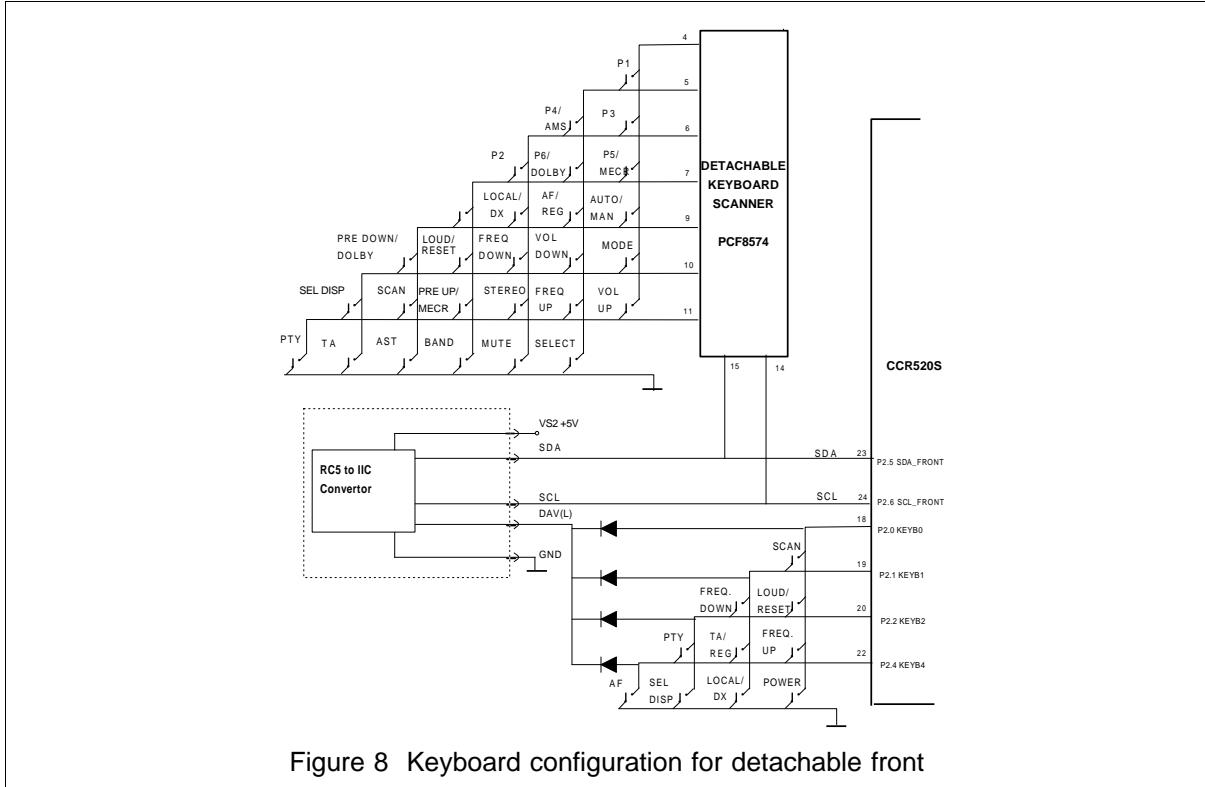


Figure 8 Keyboard configuration for detachable front

When the detachable keyboard option is chosen it is not necessary to use all the keys in the small fixed keyboard. At least the power key should be mounted when is chosen for the momentary on/off key. (Static on/off switch option disabled)

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The following table gives a short description of all pins.

| PIN | NAME | I/O | DESCRIPTION |
|------------|---------|-----|---|
| 1 | EXSTAT | I | Status of external audio jack |
| 2 | SCL | I/O | I ² C Bus Clock line |
| 3 | SDA | I/O | I ² C Bus Data line |
| 4 | RESET | I | Device reset |
| 5 | CMECR | I | Cassette ME/CR select |
| 6+16+28+39 | Vss | | GROUND |
| 7 | PILOT | I/O | Stereo indication / mono/stereo control |
| 8 | RDSCCLK | I | RDS Clock from RDS demodulator |
| 9 | SECUR | I | Security contact |
| 10 | BLPTST | I/O | Bleep output / Test input (service mode) |
| 11 | CDOLBY | I/O | Cassette Dolby select |
| 12 | RDSDAT | I | RDS Data from RDS demodulator |
| 13 | EXMUTE | O | Mute external audio source |
| 14 | XTAL2 | O | Oscillator output |
| 15 | XTAL1 | I | Oscillator input |
| 17+38 | Vdd | | +5 V supply voltage |
| 18 | KEYB0 | I/O | Keyboard matrix line 0 |
| 19 | KEYB1 | I/O | Keyboard matrix line 1 |
| 20 | KEYB2 | I/O | Keyboard matrix line 2 |
| 21 | KEYB3 | I/O | Keyboard matrix line 3 / AMS select |
| 22 | KEYB4 | I/O | Keyboard matrix line 4 |
| 23 | KEYB5 | I/O | Keyboard matrix line 5 / detach. I ² C Data |
| 24 | KEYB6 | I/O | Keyboard matrix line 6 / detach. I ² C Clock |
| 25 | HOLD | I | Power supply OK in |
| 26 | /PSEN | O | Program Store Enable (n.c.) |
| 27 | ALE | O | Address Latch Enable (n.c.) (disabled) |
| 29 | /EA | I | External Access (connect pull-up) |
| 30 | ON | O | Power supply on control |

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| PIN | NAME | I/O | DESCRIPTION |
|-----|--------|-----|---|
| 31 | TA | O | Traffic announcement in progress |
| 32 | CMUTE | O | Cassette mute |
| 33 | RMUTE | O | Radio mute |
| 34 | CDIR | I | Cassette direction (forward/reverse) |
| 35 | CINDRV | I | Cassette in drive |
| 36 | IGN | I | Ignition contact status or static on/off switch |
| 37 | CPLYWD | I | Cassette play/wind mode |
| 40 | OPTROW | O | Option row output |
| 41 | LO/DX | I/O | Local / DX control |
| 42 | LOUDN | I/O | Loudness |
| 43 | AUMUTE | O | General audio mute |
| 44 | CENABL | O | Cassette enable |

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6 KEYBOARD

The keyboard consists of a 7-line triangular matrix connected to the microcontroller or the I/O expander PCF8574. The following table lists the available keys with their functionality in radio/CD/external mode.

| NAME | DESCRIPTION |
|-----------------|---|
| P 1 | Preset-1 |
| P 2 | Preset-2 |
| P 3 | Preset-3 |
| P 4 / AMS | Preset-4 / Auto Music Search on/off (cassette) |
| P 5 / ME/CR | Preset-5 / Metal/Chromium on/off (cassette) |
| P 6 / DOLBY | Preset-6 / Dolby on/off (cassette) |
| POWER | Power on/off (momentary on/off key) |
| VOL-UP | Analog sound setting up |
| VOL-DOWN | Analog sound setting down |
| SELECT | Select analog function for update |
| MUTE | Mute on/off |
| FREQ-UP | Manual / search tuning upward |
| FREQ-DOWN | Manual / search tuning downward |
| AUTO/MANUAL | Switch between manual / search tuning |
| BAND | Cycle through bands |
| AST | Automatic search tuning band select and programming |
| AF / REG | RDS AF follow mode on/off / regional mode on/off |
| TA | RDS traffic information mode on/off |
| PTY | RDS display current PTY / enter PTY search mode |
| LOUD / RESET | Loudness on/off / Sound settings reset |
| MODE | Radio / Cassette / external selection (long pressed, display clock) |
| LOCAL / DX | Local / DX selection |
| STEREO | Suppress/enable stereo mode |
| PRE-UP / ME/CR | Programme preset up / Metal/Chromium on/off (cassette) |
| PRE-DOWN /DOLBY | Programme preset down / Dolby on/off (cassette) |
| DISPLAY | Select display (Clock display / PTY / frequency / PS name) |
| SCAN | Automatic frequency scan |

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The key's used on the infra red remote control are presented in the following table. The RC5 device code used is 11_D.

| NAME | DESCRIPTION |
|---------------|---------------|
| To be defined | To be defined |
| To be defined | To be defined |
| To be defined | To be defined |
| To be defined | To be defined |
| To be defined | To be defined |
| To be defined | To be defined |
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| To be defined | To be defined |
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| To be defined | To be defined |
| To be defined | To be defined |

7 OPTION DIODES

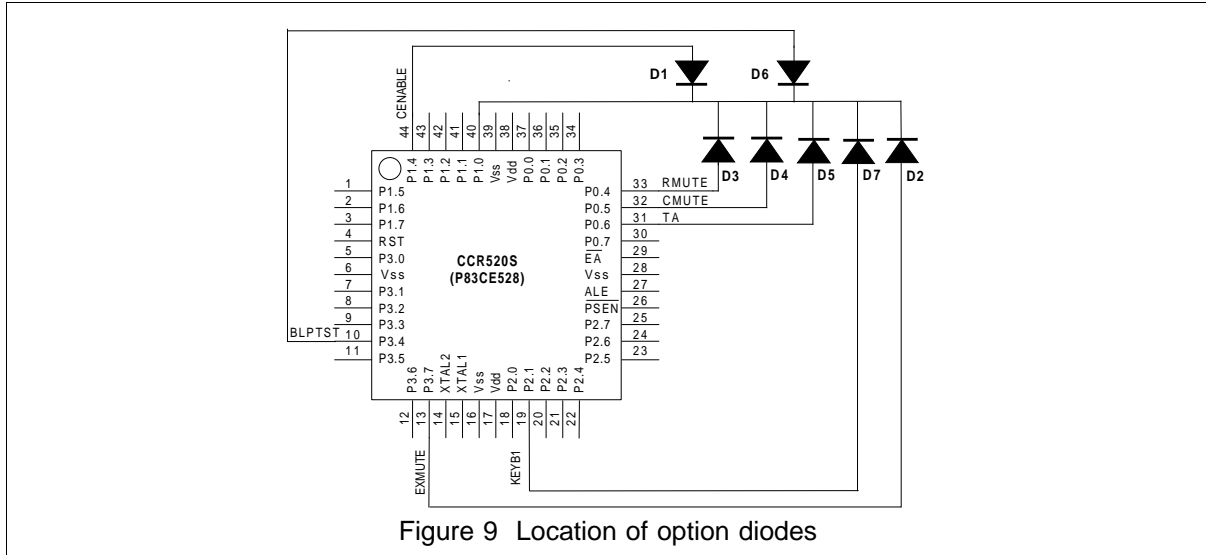


Figure 9 Location of option diodes

| Diode | Description |
|-------|----------------------------|
| D1 | Detachable front |
| D2 | FM Only |
| D3 | No LW band |
| D4 | No security |
| D5 | Static on/off switch |
| D6 | Method of source switching |
| D7 | USA application |

8 LDC DISPLAY

The Liquid Crystal Display (LCD) is driven by either one PCF8576 or two PCF8566's. Figure 10 shows all the segments of the display. To support the RDS programme service name (PS) feature, the display is equipped with 8 alpha numeric characters. With 13 segments per character, display is possible of all required RDS characters (capitals only); with 16 segments per character, umlauts and the accent can be displayed as well.

Both displays operate in 1:3 multiplex mode.

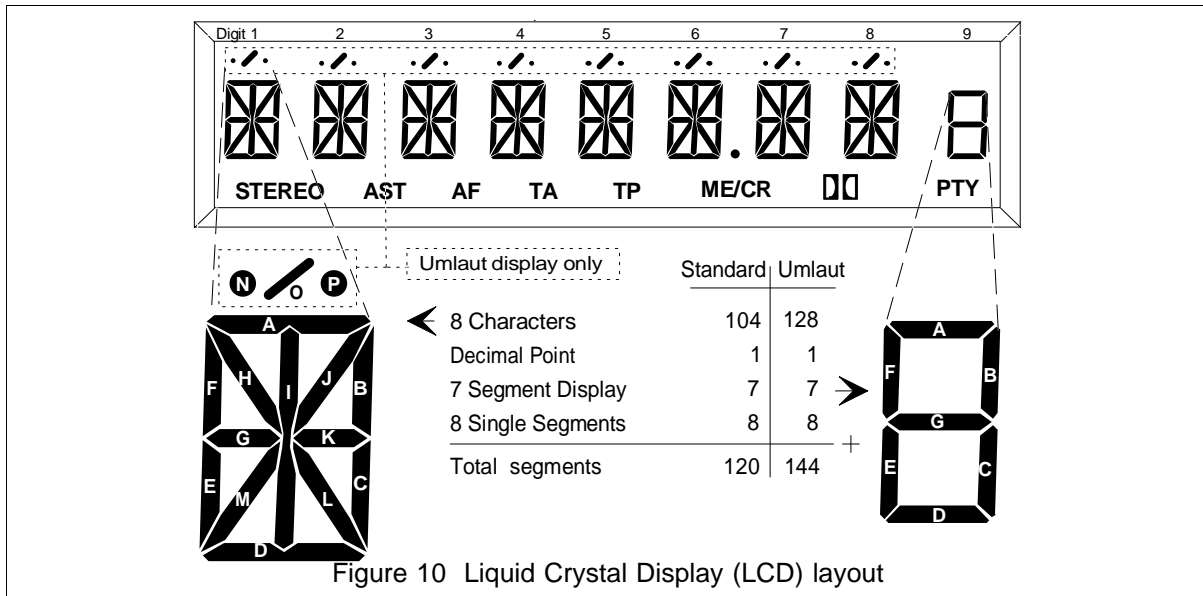


Figure 10 Liquid Crystal Display (LCD) layout