

C4210 CIRCUIT DESCRIPTION

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1. Introduction

C4210 is a 20 channel (2.4GHz) cordless telephone with CID (type I and II) and Message Waiting features.

This unit is made up of two parts:

- a. A Handset unit.
- b. A Base unit.

A security code of over 65,000 different combinations is used to prevent access by a different phone on a different line. This code is randomly and automatically changed each time the handset is placed in the cradle.

2. Functional Blocks of C4210 Handset

The block diagram of C4210 handset unit is as shown below. It is made up of the following parts:

- 2.1 Keyboard Matrix, Switches and Function LED
- 2.2 MCU and MCU Interface
- 2.3 RF Module
- 2.4 Compander
- 2.5 Data Shaper
- 2.6 Charge and Control
- 2.7 Low Battery Detector
- 2.8 Buzzer
- 2.9 Audio Circuit

3. C4210 Handset Unit Circuit Block Description

3.1 Keyboard Matrix, Switches and Function LED

The keyboard consists of the following keys:

- UP/DOWN – for menu operation
- MODE – for menu operation
- TALK – for On/Off hook control
- ENTER – for voice mail operation
- PROG – for memory program and dialing
- 1, 2, 3, 4, 5, 6, 7, 8, 9, *, 0, # – numeric keys
- FLASH — provides timed On/Off hook function
- AMB – one touch memory key
- RD/P – redials the last number or provides a pause during dialing
- MUTE – turns on/off handset microphone

The MUTE key is connected to the DSP_MODULE board.

The push switches consist of the followings:

- BOOST – for On/Off the receiver amplifier gain.
This is connected to the DSP_MODULE board.
- CH/DEL – for changing RF channel and CID/Memory operation

The function of the slide switch:

- RINGER ON/VIBRATOR/OFF – turns On/Off buzzer sound and vibrator.
- TONE 1/2/3 – varies the receiver output response.
This is connected to the DSP_MODULE board.

The keyboard, push switches and slide switch are connected to Pins 84 to 94 and pin 97 of the MCU (MCU1).

The jacks consist of the following:

- HEADSET – for connection of an external microphone and receiver
- NECKLOOP – for connection of an external receiver

The function LEDs consist of the followings:

- MICMUTE (LED19 - Red) – Located under the “MUTE” key. It is On/Off when microphone is Off/On.
- BOOST (LED13 – RED) – Located under the “TALK” key. It is On/Off

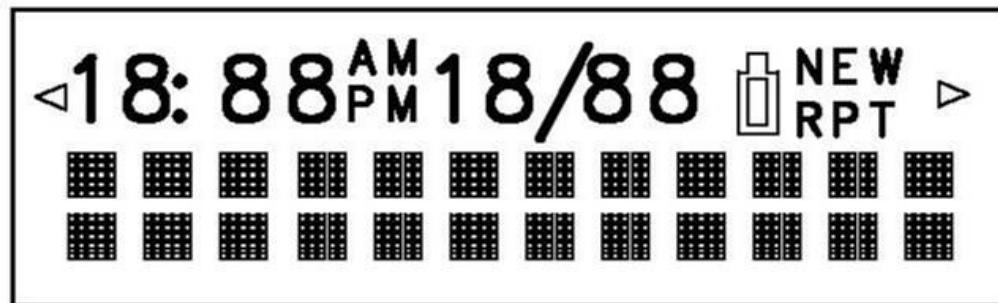
when the receiver amplifier extra gain is On/Off.

- INUSE (LED13 – GREEN) – Located under the “TALK” key. It is On/Off when the handset is Off-hook/On-hook.
- BACKLIGHT (LED1 – LED12 - Amber) – Located under the keyboard. On for a short time when any key is pressed
- LCD backlight (LED20, LED21 – Green) – On for a short time when any key is pressed
- NEWCALL (LED18 - Red) – Located under the “MODE” key. Flashes when there is incoming caller ID information to be reviewed.
- VOICEMAIL (LED17 - Blue) – Located under the “ENTER” key. Blinks when there is voice mail available.
- RINGER (LED16 - Red) – Located in the handset antenna. Flashes when the telephone line rings. Steady on/off when handset is off-hook/on-hook.

These LEDs are controlled by pins 66, 91, 96, 98 and 99 of MCU.

The MUTE and BOOST LEDs are controlled by the DSP module.

The display format of the LCD is as shown below.



The display is controlled by pins 12 – 65 of MCU.

3.2 MCU and MCU Interface

The controller of the handset is MCU1. The frequency of the crystal used is 32.768 KHz. It controls the functions of the handset through the keyboard interface and signals from the base unit. The data to and from the base goes through pin 69 (data from base) and pin 71 (data to base).

The phone number memories are stored in U13.

3.3 RF Section

For operation and frequency see RF module section.

It receives the PLL data through pins 4, 5, 6 from MCU pins 95, 93 and 94.

The antenna located at the top of the unit and is permanent attached to RF module through a copper wire.

3.4 Comander

A compander U11 is used for improving the S/N of transmit and receive audio signals.

3.5 Data Shaper

The information which sent from base unit is recovered by the amplifier Q8, Q25 and Q26.

3.6 Charge and Control

ZD2, D304, D305, D306, D307, D21, D22 provide over-voltage and polarity protection during battery charging. The charge signal is detected by pin 87 of the MCU. When the handset is put into the base cradle, a negative pulse is sent to pin 74 of the MCU.

3.7 Low Battery Detector

The battery voltage is detected by U1-B and Q22. The signal is sent to pin 67 of MCU.

3.8 Buzzer and Vibrator

Q3 is the buzzer signal amplifier and driven by the MCU pins 72.

Q15 is the on/off control device for the vibrator.

3.9 Audio Circuit

The DSP module checks the “TONE” switch, the “MUTE” key and the “BOOST” switch and turn on/off the MUTE and BOOST LEDs.

Speech signal is picked up by the handset microphone MIC1 and sent to the gain control module U3 (DSP_MODULE) and sent to telephone line through the compander U11 and the RF module.

The incoming speech is received through the RF module, the compander, the gain control module U3 (DSP_MODULE) and amplifier U2. When BOOST mode is On, extra gain is inserted in this audio path by U3 (DSP_MODULE).

The headset jack is for external receiver and microphone.

The neckloop jack is for an external hearing aid device.

3.10 DSP Module

The DSP_Module controls the gain and frequency response of the speech signal.

The brain of its operation is a TI DSP controller (U6) which provides the following functions:

- a. controls the CODEC (U2);
- b. scan the Timer (U5);
- c. scan the Tone switch (SW5);
- d. scan the “BOOST” switch (SW2);
- e. scan the “MUTE” key;
- f. scan the setting of the Volume (VR1); and
- g. on/off the “BOOST” and “MUTE” LEDs.

This DSP runs with a crystal of clock frequency 24.576 MHz.

The EEPROM (U7) provides the main program storage for U6.

The timer IC (U5) is used to measure the setting of the Volume control.

The handset microphone signal is picked up by the DSP_Module pin 1, Op Amp (U1) and then pin 2 of the CODEC (U2). The processed signal is sent out from CODEC (U2) pin 15, Op Amp (U3), and the DSP_Module pin 34.

The audio signal from telephone line is picked up by the DSP_Module pin 2, CODEC (U2) pin 3. The processed signal is sent out from CODEC (U2) pin 16, and the DSP_Module pin 35. The gain is depending on the VOLUME setting.

When BOOST mode is “On”, the DSP will adjust gain/frequency response depending on the combination of signal amplitude, frequency and the settings of the TONE switch (SW5).

4. Functional Blocks of C4210 Base Unit

The block diagram of C4210 base unit is as shown below. It is made up of the following parts:

- Power Supply
- MCU and MCU Interface
- RF Module
- Compander
- Data Shaper
- Charge and Control
- Telephone Line Interface
- Ring Signal Detector
- Base Ringer
- Keyboard Matrix, Switches and Function LED

5. C4210 Base Unit Circuit Block Description

5.1 Power Supply

The base unit is powered by an AC adapter (9V dc). The voltage regulator (BU3) regulates the input DC to 5V. This provides power to every part of the unit.

When there is no AC power, BQ18 and BQ19 are turned on to connect the backup batteries to power the base while BZD2 controls the regulated battery output voltage to approximately 5V. The backup batteries voltage is checked periodically by BU7A and this signal is connected to pin 39 of the MCU.

5.2 MCU and MCU Interface

The controller of the base is BMCU1 and controls the function of the unit.

On the telephone side,

- A. It monitors telephone line ring signal at pin 7.
- B. It monitors parallel phone hook status (MEI) at pin 5 through BU7-B (LM358).
- C. Decodes CID (Type 1 and Type II) and Message Waiting signals through pin 8 and pin 9.
- D. It provides DTMF signal at pin 2.

The keyboard interface is provided by pins 17 – 24.

It communicates with the handset through the RF module. PLL data to the RF module BJW3 is sent through pins 29, 37 and 44.

The data between Handset and Base is via the pin 41 (data from handset) and pin 43 (data to handset) through the RF module.

The transmitter and receiver powers are controlled by the signals from BU2-pin5 and pin6 which are programmed by BMCU1.

The frequency of the crystal used is 32.768 KHz.

5.3 RF Module

For operation and frequency see RF module section..

It receives the PLL data through pins 4, 5, 6 from MCU pins 44, 29 and 37.

The antenna located inside the base of the unit is permanent attached to RF module.

5.4 Comander

The compander BU1 is used for improving the S/N of the transmit and receive audio signals.

5.5 Data Shaper

The information sent from handset unit is recovered by the amplifier BQ15, BQ28 and BQ29.

5.6 Charge and Control

BQ4 detects the handset charging current and sends signal to MCU pin 38. BQ2, BQ13, BQ36 and BQ16 control the charging current delivered to the handset. Resistors BR108 and BR109 provide current limiting function. BQ5 detect the 9V supply and send a negative pulse to MCU pin 40 if the 9V supply fails.

5.7 Telephone Line Interface

BL1, BL2, BF1, BVAR1, BR149 and BC61 provide telephone line surge protection. BQ3, BD24, BD25, BD26, BD27, BU6 provide telephone On/Off hook function. BD3, BR34 and BT1 line transformer are the audio interface to the telephone line. The transformer BT1 is also used for telephone line isolation.

5.8 Ring Signal Detector

BL1, BC57, BR31, BZD6, BZD5, BD2, BU5, BF1 and BL2 form the ring signal detector. The signal is sent to pin 7 of MCU.

5.9 Base Ringer

BU11 and speaker BSPK1 provide base ringer sound output. MCU pin 42 provides ringer tones (six types), and this is set by MCU pin 20 (RING STYLE). The level is controlled by pin 18 (VOLUME UP), or pin 19 (VOLUME DOWN). The MCU then sets the output pins 15, 1 – 5 of BU4 (74HC595) which controls the ringer sound output level through transistors BQ30 – BQ35.

5.10 Keyboard Matrix, Switches and Function LEDs

The keyboard and switches consist of the followings:.

- PAGE – for base to page handset
- STYLE – for changing Ringer sound frequency
- VOLUME DOWN – for reducing Ringer sound output volume
- VOLUME UP – for increasing Ringer output sound volume
- RINGER ON/OFF – turns On/Off the ringer output
- BOOST ON/OFF – turns On/Off handset receiver extra gain
- T/P – for selecting Tone or Pulse mode dialing

The switches are connected to pins 17 - 24 of MCU (BMCU1).

The function LEDs consist of the followings:

- **RINGER** (BLED6, BLED7 – Red) – Located under the antenna red lens. They are controlled by transistor BQ11 and pin 36 of MCU (BMCU1).
- **INUSE** (BLED21 – Green) – Green when C4210 is talking to the telephone line. It is controlled by transistor BQ6 and pin 15 of BU2 which is set by BMCU1.
- **CHARGE** (BLED31 – Red) – Red when handset is the cradle. It is controlled by transistor BQ10 and pin 7 of BU2 which is set by BMCU1.
- **POWER** (BLED11, BLED12 – Green/Red) – Indicates base power conditions. This is controlled by transistors BQ23, BQ27 and BU2-pin 1 which is set by BMCU1.
 - Green – when the base is powered by AC adapter and good batteries.
 - Red – when the base is powered by AC adapter only.
 - Blinking Red/Green – when the base is powered AC adapter with bad batteries.
 - Blinking Red – when the base is powered by good batteries only.
 - Flashing Red – when the base is powered by batteries and the battery voltage is low.

6. Functional Blocks of the RF Modules

The block diagram of RF Module is as shown below. It is made up of the following parts:

- 6.1 Power Supply
- 6.2 PLL and MCU Interface
- 6.3 RF Transmitter
- 6.4 RF Receiver
- 6.5 Audio Detector

7. RF Module Circuit Block Description

7.1 Power Supply

The RF transmitter (Q6, Q7, and Q1) receives power from TXVCC. This voltage is 5V for the base unit and 3.6V for the handset unit. For the base unit, TXVCC is enabled only during TALK or RINGING mode. For the handset unit, TXVCC is enabled only during TALK mode.

The RF receiver (Q3) receives power from RXVCC. This voltage is 5V for the base unit and 3.6V for the handset unit.

For the base unit, RXVCC is enabled all the time when there is AC power. When running on backup batteries, it is on only while scanning for “TALK” signal from the handset.

For the handset unit, RXVCC is enabled only during TALK or scanning for ringing signal from the base unit.

7.2 PLL and MCU Interface

The frequencies of the RF transmitter and RF local oscillator are controlled by a PLL IC (U1). It receives the frequency data through DATA, CLK and CE signal lines from the MCU. The basic clock frequency of the PLL is derived from an 11.15MHz crystal (X1) inside the RF module.

7.3 RF Transmitter

The RF transmitter frequency for the base is 2400.550 MHz – 2401.500 MHz and the handset is 2481.550 MHz – 2482.500 MHz.

The RF transmitter signal is derived from Q1 which consists of a fundamental (1/3 the frequency of the transmitter) and its 3rd harmonic. The transmit frequency is controlled by the signal pin CPO of the PLL IC (U1). The PLL samples the RF frequency through FIN. The audio input signal AFIN is fed to this RF oscillator through the FM modulator VD1.

The third harmonic of RF oscillator output is amplified through the “2.4GHz LNA” (Q7, Q6) and coupled to the RF antenna through the TX_FILTER (DF1).

7.4 RF Receiver

The incoming RF signal is coupled from the antenna through RX_FILTER (DF2) to a LNA (Q3) where it is amplified and fed to the 1st mixer (Q4). Q2 is the local oscillator and its signal output is a fundamental (1/3 frequency of the required local oscillator) and its 3rd harmonic. The 3rd harmonic is selected by the filter “FILTER 2.4GHz” (C50, C26, C25, ML13, ML11, and C28).

The frequency of the output from Q2 is controlled by the signal pin CPOA of

the PLL IC (U1). The PLL samples the local oscillator RF frequency through signal pin FINA.

For the base unit, the operating frequency is 3xVCO – 10.7MHz.

For the handset unit, the operating frequency is 3xVCO + 10.7MHz.

7.5 Audio Detector

The audio detector receives the incoming signal from the 10.7MHz amplifier (Q5). The audio signal is recovered by a FM detector (U2) and sent to AFOUT. The quality of the incoming RF signal is indicated by logic output NOISE.

11. RF Channels

RF CHANNEL	HANDSET (KHz)		BASE (KHz)	
	TX	RX	TX	RX
01	2,481,550	2,389,850	2,400,550	2,492,250
02	2,481,600	2,389,900	2,400,600	2,492,300
03	2,481,650	2,389,950	2,400,650	2,492,350
04	2,481,700	2,390,000	2,400,700	2,492,400
05	2,481,750	2,390,050	2,400,750	2,492,450
06	2,481,800	2,390,100	2,400,800	2,492,500
07	2,481,850	2,390,150	2,400,850	2,492,550
08	2,481,900	2,390,200	2,400,900	2,492,600
09	2,481,950	2,390,250	2,400,950	2,492,650
10	2,482,000	2,390,300	2,401,000	2,492,700
11	2,482,050	2,390,350	2,401,050	2,492,750
12	2,482,100	2,390,400	2,401,100	2,492,800
13	2,482,150	2,390,450	2,401,150	2,492,850
14	2,482,200	2,390,500	2,401,200	2,492,900
15	2,482,250	2,390,550	2,401,250	2,492,950
16	2,482,300	2,390,600	2,401,300	2,493,000
17	2,482,350	2,390,650	2,401,350	2,493,050
18	2,482,400	2,390,700	2,401,400	2,493,100
19	2,482,450	2,390,750	2,401,450	2,493,150
20	2,482,500	2,390,800	2,401,500	2,493,200