

C4205 Circuit Description

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1. Introduction

The model C4205 is a 20 channel (2.4GHz) cordless telephone.

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 the Handset

The block diagram of C4205 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 Comander
- 2.5 Data Shaper
- 2.6 Charge and Control
- 2.7 Low Battery Detector
- 2.8 Buzzer
- 2.9 Audio Circuit

3.1 Keyboard Matrix, Switches and Function LED

The keyboard consists of the following keys:

- FIRE – one touch memory key
- POL – one touch memory key
- AMB – one touch memory key
- CHN – for changing RF carrier frequency
- TALK – for On/Off hook control
- MEM – for memory program and dialing
- 1, 2, 3, 4, 5, 6, 7, 8, 9, *, 0, # – numeric keys
- FLASH – provides timed On/Off hook function
- RDL/P – redials the last number or provides a pause during dialing.

The keyboard is connected to Pins 19 to 20, 22 to 26 and 30 of the MCU (U1).

- MUTE – turns Off/On the handset microphone

The MUTE key is connected to the DSP_MODULE board.

The switches consist of the followings:

- BOOST CLARITY POWER – for On/Off the receiver amplifier gain. This is connected to the DSP_MODULE board.
- RINGER ON/VIBRATOR/OFF – turns On/Off the ringer buzzer and the vibrator. This is connected to pins 21 and 38 of MCU.

The function LEDs consist of the followings:

- MICMUTE (LED317 - Red) – Located under the “MUTE” key. On/Off when microphone is Off/On
- INUSE (LED316 – Green; LED301 - Red) – Located under the “TALK” key and the handset antenna. On/Off when telephone is Off-hook/On-hook
- BOOST (LED316 – RED) – Located under the “TALK” key. On/Off when the receiver amplifier extra gain is On/Off
- BACKLIGHT (LED304 – LED315 – Orange) – Located under the keyboard. On for a short time when any key is pressed
- RINGER (LED301 - Red) – Located in the handset antenna. Flashes when the telephone line rings

These LEDs are controlled by pins 9, 11, 12 of MCU and the DSP_MODULE board.

3.2 MCU and MCU Interface

The controller of the handset is U1. The frequency of the crystal used is 4.09 MHz. 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 31 (data from base) and pin 34 (data to base).

3.3 RF Module

For operation and frequency see RF module section.

It receives the PLL data through RFM1 pins 4, 5, 6 from MCU pins 44, 43, and 1.

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 U201 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 Q201 and Q202.

3.6 Charge and Control

ZD201, Q207, D212, D213, D214, D215, D218, D219 provide polarity and over-voltage protection during battery charging. The charge signal is detected by pin 29 of the MCU.

When the handset is put into the base cradle, a negative pulse is sent to pin 14 of the MCU.

3.7 Low Battery Detector

The battery voltage is detected by U6B and Q1. The signal is sent to pin 4 of MCU.

3.8 Buzzer and Vibrator

Q204 is the buzzer signal amplifier and driven by the MCU pins 2, 32, 33.

Q301 is the switch to turn on the vibrator. It receives its control signal from pin 39 of the MCU.

3.9 Audio Circuit

Speech signal is picked up by the internal microphone MIC1 and sent to the gain control module U8 (DSP_MODULE) and sent to telephone line through the compander U201 and the RF module.

The incoming speech is received through the RF module, the compander, the gain control module U8 (DSP_MODULE) and amplifier U2.

When BOOST is On, extra gain is inserted in this audio path.

The headset jack is for external speaker and microphone.

The neckloop jack is for an external hearing aid device.

U7 provides regulated +3.0V for U8 and is controlled by U1 pin 41.

The power to the power amplifier U2 is supplied by Q15 which is controlled by U1 pin 35.

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 (SW4);
- d. scan the “BOOST” switch (SW3);
- 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 (X1).

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 add extra gain in the receive path depending on the signal frequency and amplitude. At the same time, it adjusts the

microphone gain depending on the incoming speech level.

4. Functional Blocks of the Base unit

The block diagram of C4205 base unit is as shown below. It is made up of the following parts:

- 4.1 Power Supply
- 4.2 MCU and MCU Interface
- 4.3 RF Module
- 4.4 Compander
- 4.5 Data Shaper
- 4.6 Charge and Control
- 4.7 Telephone Line Interface
- 4.8 Ring Signal Detector
- 4.9 Base Ringer
- 4.10 Keyboard Matrix, Switches and Function LED

5. Base Unit Circuit Block Description

5.1 Power Supply

The base unit is powered by an AC adapter (9V dc).

The voltage regulator (BU4) regulates the input DC to 5V. This provides power to every part of the unit.

When there is no AC power, BQ13 and BQ15 are turned on to connect the backup batteries to power the base. The backup batteries voltage is checked periodically by BU2-A and this signal is connected to pin 5 of the MCU.

5.2 MCU and MCU Interface

The controller of the base is BUX and controls the function of the unit. The frequency of the crystal used is 8 MHz.

It communicates with the handset through the RF module. PLL data to the RF module BRFM1 is sent through pins 1, 43 and 44. The data between Handset and Base is via the pin 31 (data from handset) and pin 34 (data to handset) through the RF module. The transmitter power is controlled by the signal from pins 26 and 35 of MCU.

The MCU monitors ring signal from telephone line through the telephone line interface at pin 29. MCU pins 19 to 24 provide DTMF signal through a resistor ladder connected at these pins. The keyboard interface is provided by pins 9 to 12.

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 1, 43 and 44.

The antenna located inside the plastic cabinet 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 signal.

5.5 Data Shaper

The information sent from handset unit is recovered by the amplifier BQ2 and BQ3.

5.6 Charge and Control

BU2-B detects the handset charging current and sends signal to MCU pin 30.

MCU pin 37 detects the 9V supply. MCU pin 1 detects both the 9V supply and the batteries.

5.7 Telephone Line Interface

BL3, BL4, BF1 and BVAR1 provide telephone line surge protection.

BQ7, BD12, BD13, BD14, BD15, BC69, BU7 provide telephone On/Off hook function. BD2, BR118 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

BL3, BC68, BR116, BZD2, BZD3, BD11, BU6, BF1 and BL4 form the ring signal detector. The signal is sent to pin 29 of MCU.

5.9 Base Ringer

Base ringer sound output is provided by BU3 and speaker BSP1. MCU pin 2 provides the ringer output signal and the level is controlled by pins 38, 39, 36, 32, 27 and 28.

5.10 Keyboard Matrix, Switches and Function LEDs

The keyboard and switches consist of the followings:

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

They are connected to pins 3, 9 – 12 and 19 of MCU (BU2).

The visual ringing signal is provided by LEDs BLED8 and BLED9 (Red) and located under the red lens. They are controlled by pin 12 of MCU.

BLED21 (Green) is used for indicating “INUSE” when the telephone is off-hook. This is controlled by pin 11 of MCU.

BLED31 (Red) is used to indicate “CHARGING” when handset is in cradle. This is controlled by BU2-B.

BLED12 (Red) and BLED11 (Green) indicate base power conditions. They are controlled by MCU pin 9 and pin 10.

- 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 Module

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 filter and 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.

10. 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