W425D/W425Pro Circuit Description

CONTENT

1. Introduction

The models W425D and W425Pro are 10 channel (900 MHz) cordless telephones.

Both models are made up of two parts:

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

Both models (W425D/W425Pro) have a module in the handset to control the audio output gain and frequency response. W425D is using a DSP audio module while W425Pro is using an analog audio module.

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 when the handset is placed in the cradle.

2. Functional Blocks of the Handset

The block diagram of 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

- W425D – DSP Module
- W425DPro – ANALOG Module

3.1 Keyboard Matrix, Switches and Function LEDs

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 9, 20, 21, 28, 29, 30, 31, 41, 42 and 43 of the MCU (MCU1).

- MUTE – turns Off/On the handset microphone
  The MUTE key is connected to the audio module board.

The switches consist of the followings:

- BOOST CLARITY POWER – for On/Off the receiver amplifier gain. This is connected to the audio module board.
- RINGER ON/OFF – turns On/Off the ringer buzzer. This is connected to pin 14 of MCU.

The function LEDs consist of the followings:

- MUTE (LED317 - Red) – Located under the “MUTE” key. On/Off when microphone is Off/On.
- INUSE (LED9 - Red) – Located under the “TALK” key. On/Off when telephone is Off-hook/On-hook
- BACKLIGHT (LED304 – LED311 – Orange) – Located under the keyboard. On for a short time when any key is pressed.
- BOOST/RINGER (LED301 - Red) – Located in the handset antenna. Flashes when the telephone line rings. Steady on when the receiver amplifier extra gain is on.

These LEDs are controlled by pins 6, 63 and 64 of MCU and the audio module board.

3.2 MCU and MCU Interface

The controller of the handset is MCU1. Its clock frequency is controlled by a resonator of 8.00 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 22 (data from base) and pin 61 (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 32, 33 and 34. The antenna is located at the top of the unit and is attached permanently to the RF module.

3.4 Compander

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

D214 provides polarity protection during battery charging. The charge signal is detected by pin 24 of the MCU.
When the handset is put into the base cradle, a negative pulse is sent to pin 8 of the MCU.
U3 provides a regulated voltage +3.0V from the battery. This provides power to every part of the PCB.

3.7 Low Battery Detector

The battery voltage is detected by Q2 and Q9. This signal is sent to pin 23 of MCU.

3.8 Buzzer

Q6 turns on/off the buzzer and is driven by the MCU pins 7 and 62.

3.9 Audio Circuit

Speech signal is picked up by the internal microphone MIC1 and sent to the gain control module U8 (a DSP MODULE for W425D/an ANALOG MODULE for W425Pro). The speech signal is then 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 and amplifier U1.
When BOOST is ON, extra gain is inserted in this audio path.

The headset jack is for external receiver and microphone.

U1 pin 64 controls Q8 which supplies power to the module U8 and on/off of amplifier U1.

3.10 W425D - 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 (SW2);
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.

3.11 W425Pro - ANALOG Module

The ANALOG Module controls the gain and frequency response of the speech signal. Its operation is provided by a PIC controller (U1) which provides the following functions:

h. scan the “BOOST” switch (SW3);
i. scan the “MUTE” key;
j. scan the setting of the Volume (VR1); and
k. on/off the “BOOST” and “MUTE” LEDs;
l. enable/disable the Tone switch (SW2).

The handset microphone signal is picked up by the Analog Module at pin P1, amplified by Op Amp (U2-B, U2-A) and out of the module at pin P34. The PIC (U1) checks the volume VR1 settings and determines this transmit path gain through Q2 and U3. The PIC (U1) also measures the microphone signal level through U2-C and determines when to reduce the receiver path audio gain.
When the “MUTE” key is pressed, PIC (U1) toggles pin 8 to turn ON/OFF the “MUTE” LED and the transistors Q1, Q3 to mute/un-mute the microphone signal.

The audio signal from telephone line is picked up by the Analog Module at pin P2, MUX (U4). The frequency shaped signal is sent out through U2-D, U5 and the Analog Module pin P35. The receive path gain is controlled by PIC (U1) through MUX (U3) and FET (Q4) depending on the VOLUME (VR1) setting.
When BOOST mode is “On”, the PIC will change the MUX (U3) settings to modify the receiver path gain. Also, the PIC enables the “TONE” switch to control MUX (U4) which varies the signal frequency response.

4. Functional Blocks of the Base unit

The block diagram of W425D/EW425Pro 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 (7.5 Vdc).
The voltage regulator (BU3) regulates the input DC to 3.8 Vdc. This provides power to every part of the unit.

5.2 MCU and MCU Interface

The controller of the base is BMCU1 and controls the function of the unit. Its clock frequency is controlled by a resonator of 8.00MHz.
It communicates with the handset through the RF module. PLL data to the RF module BRFM1 is sent through pins 32, 33 and 34. The data between Handset and Base is via the pin 22 (data from handset) and pin 61 (data to handset) through the RF module. The transmitter power is controlled by the signal from pin 28.
The MCU monitors ring signal from telephone line through the telephone line interface at pin 23. MCU pins 10 to 15 provide DTMF signal through a resistor ladder connected at these pins. The keyboard and switch interfaces are provided by pins 20, 24, 26, 26, 29, 30 and 31.

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 32, 33 and 34.
The antenna located inside the plastic cabinet is permanently attached to the RF module.

5.4 Compander

The compander SU2 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 BQ4 and BQ5.

5.6 Charge and Control

MCU pin 17 detects the handset charging current.

5.7 Telephone Line Interface

BL1, BL2, BF1 and BVAR1 provide telephone line surge protection. BQ13, BQ34, BD24, BD25, BD26 and BD27 provide telephone On/Off hook function. BQ33 is the audio interface to the telephone line.

5.8 Ring Signal Detector

BC63, BR81, BC51, BR12, BD12, BR89 and BQ7 form the ring signal detector. The signal is sent to pin 23 of MCU.

5.9 Base Ringer

Base ringer sound output is provided by BU5 and speaker BSP1. MCU pin 62 provides the ringer output signal and the level is controlled by pins 39 to 43.

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 sound
- CLARITY ON/OFF – turns On/Off handset receiver extra gain
- PULSE/TONE – for selecting Pulse or Tone mode dialing

They are connected to pins 30, 24, 29, 31, 25, 20 and 26 of MCU (BU4).

The visual ringing signal is provided by BLED7 (Red) and located under the red lens. It is controlled by pin 64 of MCU.
BLED2 (Green) is used for indicating both “INUSE” when the telephone is off-hook and handset is in cradle charging. This is controlled by pins 6 and 7 of MCU.

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 (900MHz LNA) receives power from VTX. This voltage is 3.8V for the base unit and 3.0V for the handset unit. For the base unit, VTX is enabled only during TALK or RINGING mode. For the handset unit, VTX is enabled only during TALK mode.

The RF receiver (DQ3) receives power from VRX. This voltage is 3.8V for the base unit and 3.0V for the handset unit.

For the base unit, VRX is enabled all the time when there is AC power. For the handset unit, VRX 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 (DU2). 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 (DX1) inside the RF module.

7.3 RF Transmitter

The RF transmitter frequency for the base is 902.200 MHz – 904.000 MHz and the handset is 926.000 MHz – 927.800 MHz.

The RF transmitter signal is derived from DQ1. The transmit frequency is controlled by the signal pin CP1 of the PLL IC (DU2). The PLL samples the RF frequency through FIN1. The audio input signal MOD is fed to this RF oscillator through the FM modulator DVD1.

The RF oscillator output is amplified through the “900 MHz LNA” (DQ8) and coupled to the RF antenna through the TX_FILTER which is made up of capacitors and inductors.

7.4 RF Receiver

The incoming RF signal is coupled from the antenna through RX_FILTER (DDF1) to a LNA (DQ3) where it is amplified and fed to the 1st mixer (DQ2) and IF amplifier DQ6.

DQ7 is the local oscillator. The frequency of the output from DQ7 is controlled by the signal pin CP2 of the PLL IC (DU2). The PLL samples the local oscillator RF frequency through signal pin FIN2.

For the base unit, the operating local oscillator frequency is
(Received RF + 10.7MHz).
For the handset unit, the operating local oscillator frequency is
(Received RF – 10.7MHz).

7.5 Audio Detector

The audio detector receives the incoming signal from the 10.7MHz filter and amplifier (DQ6). The audio signal is recovered by a FM detector (DU1) and sent to pin AF.
The quality of the incoming RF signal is indicated by logic output ND. For handset, this signal is not used.

10. RF Channels

CHANNEL	BASE		HANDSET	
	TX (MHz)	LOCAL (MHz)	TX (MHz)	LOCAL (MHz)
CH 01	902.200	936.700	926.000	891.500
CH 02	902.400	936.900	926.200	891.700
CH 03	902.600	937.100	926.400	891.900
CH 04	902.800	937.300	926.600	892.100
CH 05	903.000	937.500	926.800	892.300
CH 06	903.200	937.700	927.000	892.500
CH 07	903.400	937.900	927.200	892.700
CH 08	903.600	938.100	927.400	892.900
CH 09	903.800	938.300	927.600	893.100
CH 10	904.000	938.500	927.800	893.300

C410 Circuit Description

CONTENT

1. Introduction

The model C410 is a 10 channel (900 MHz) 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 C410 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

3.1 Keyboard Matrix, Switches and Function LEDs

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.
- MUTE – turns Off/On the handset microphone

The keyboard is connected to Pins 9, 20, 21, 28, 29, 30, 31, 41, 42 and 43 of the MCU (U2).

The switches consist of the followings:

- BOOST CLARITY POWER – for On/Off the receiver amplifier gain. This is connected to U2 pin 25.
- RINGER ON/OFF – turns On/Off the ringer buzzer. This is connected to pin 14 of MCU.

The function LEDs consist of the followings:

- MUTE (LED7 - Red) – Located under the “MUTE” key. On/Off when microphone is Off/On.
- INUSE (LED6 - Red) – Located under the “TALK” key. On/Off when telephone is Off-hook/On-hook
- BACKLIGHT (LED2 – LED5 – Orange) – Located under the keyboard. On for a short time when any key is pressed.
- BOOST/RINGER (LED1 - Red) – Located in the handset antenna. Flashes when the telephone line rings. Steady on when the receiver amplifier extra gain is on.

These LEDs are controlled by pins 35/36, 64, 6 and 63 of MCU.

3.2 MCU and MCU Interface

The controller of the handset is U2 . Its clock frequency is controlled by a resonator of 8.00 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 22 (data from base) and pin 61 (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 32, 33 and 34. The antenna is located at the top of the unit and is attached permanently to the PCB.

3.4 Compander

A compander U3 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 Q7 and Q9.

3.6 Charge and Control

D4 provides polarity protection during battery charging. The charge signal is detected by pin 24 of the MCU.
When the handset is put into the base cradle, a negative pulse is sent to pin 8 of the MCU.
U4 provides a regulated voltage +3.0V from the battery. This provides power to every part of the PCB.

3.7 Low Battery Detector

The battery voltage is detected by pin 16 of MCU at which reads the voltage level of junction of R7 and R93.

3.8 Buzzer

Q1 turns on/off the buzzer and is driven by the MCU pins 7 and 62.

3.9 Audio Circuit

Speech signal is picked up by the internal microphone M1 and amplified by Q6 and then to telephone line through the compander U3 and the RF module.

The incoming speech is received through the RF module, the compander. When BOOST is OFF, this audio signal is routed through the signal switch Q14. When BOOST is ON, this audio signal is routed through the amplifier Q8 and the signal switch Q13.

Then it goes through the signal attenuator resistor ladder and then the amplifier U1.

The signal attenuator resistor ladder is controlled by MCU pins 37 – 40. MCU pin 27 (\TX_PWR) controls on/off of amplifier U1.

The headset jack is for external receiver and microphone.

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4. Functional Blocks of the Base unit

The block diagram of C410 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 (7.5 Vdc).
The voltage regulator (BU3) regulates the input DC to 3.8 Vdc. This provides power to every part of the unit.

5.2 MCU and MCU Interface

The controller of the base is BU4 (BU1 – adapter) and controls the function of the unit.
Its clock frequency is controlled by a resonator of 8.00MHz.
It communicates with the handset through the RF module. PLL data to the RF module is sent through pins 32, 33 and 34. The data between Handset and Base is via the pin 22 (data from handset) and pin 61 (data to handset) through the RF module. The transmitter power is controlled by the signal from pin 28.
The MCU monitors ring signal from telephone line through the telephone line interface at pin 23. MCU pins 10 to 15 provide DTMF signal through a resistor ladder connected at these pins. The keyboard and switch interfaces are provided by pins 20, 24, 25, 26, 29, 30 and 31.

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 32, 33 and 34.
The antenna located inside the plastic cabinet is permanently attached to the RF module.

5.4 Compander

The compander MU1 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 BQ4 and BQ5.

5.6 Charge and Control

MCU pin 17 detects if the handset is put for charging.

5.7 Telephone Line Interface

BL1, BL2, BF1 and BVAR1 provide telephone line surge protection. BQ13, BQ35, BQ34, BD24, BD25, BD26 and BD27 provide telephone On/Off hook function. BQ33 is the audio interface to the telephone line.

5.8 Ring Signal Detector

BC63, BR81, BC51, BR12, BD12, BR98 and BQ7 form the ring signal detector. The signal is sent to pin 23 of MCU.

5.9 Base Ringer

Base ringer sound output is provided by BU5 and speaker BSP1. MCU pin 62 provides the ringer output signal and the level is controlled by pins 39 to 43.

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 sound
- CLARITY ON/OFF – turns On/Off handset receiver extra gain
- T/P – for selecting Tone or Pulse mode dialing

They are connected to pins 30, 24, 29, 31, 25, 20 and 26 of MCU (BU4).

The visual ringing signal is provided by BLED7 (Red) and located under the red lens. It is controlled by pin 64 of MCU.
BLED2 (Green) is used for indicating both “INUSE” when the telephone is off-hook and handset is in cradle charging. This is controlled by pins 6 and 7 of MCU.

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 (DQ8) receives power from VTX. This voltage is 3.8V for the base unit and 3.0V for the handset unit. For the base unit, VTX is enabled only during TALK or RINGING mode. For the handset unit, VTX is enabled only during TALK mode.

The RF receiver (DQ3) receives power from VRX. This voltage is 3.8V for the base unit and 3.0V for the handset unit.

For the base unit, VRX is enabled all the time when there is AC power. For the handset unit, VRX 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 (DU2). 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 (DX1) inside the RF module.

7.3 RF Transmitter

The RF transmitter frequency for the base is 902.200 MHz – 904.000 MHz and the handset is 926.000 MHz – 927.800 MHz.

The RF transmitter signal is derived from oscillator (DQ1). The transmit frequency is controlled by the signal pin CP1 of the PLL IC (DU2). The PLL samples the RF frequency through FIN1. The audio input signal MOD is fed to this RF oscillator through the FM modulator (DVD1).

The RF oscillator output is amplified through the “900 MHz LNA” (DQ8) and coupled to the RF antenna through the TX_FILTER which is made up of capacitors and inductors.

7.4 RF Receiver

The incoming RF signal is coupled from the antenna through RX_FILTER (DDF1) to a LNA (DQ3) where it is amplified and fed to the 1st mixer (DQ2) and IF amplifier (DQ6).

The frequency of the output from the local oscillator (DQ7) is controlled by the signal pin CP2 of the PLL IC (DU2). The PLL samples the local oscillator RF frequency through signal pin FIN2.

For the base unit, the operating local oscillator frequency is
(Received RF + 10.7MHz).
For the handset unit, the operating local oscillator frequency is
(Received RF – 10.7MHz).

7.5 Audio Detector

The audio detector receives the incoming signal from the 10.7MHz filter and amplifier (DQ6). The audio signal is recovered by a FM detector (DU1) and sent to pin AF.
The quality of the incoming RF signal is indicated by logic output ND. For handset, this signal is not used.

Notes on RF modules:

A. Base RF module is a discrete PCB assembly which is connected by array wires to base main PCB.

B. Handset RF module is assembled at a local region on the same PCB of handset main circuit.

C. Component designators in RF circuit descriptions 7.1 to 7.5 are for the base side. For handset RF operations, 7.1 to 7.5 is the same but just component designators starting letters are replaced by 'H' instead of 'D'. For example, DQ6 is replaced by HQ6 and DU1 is replaced by HU1.

10. RF Channels

CHANNEL	BASE		HANDSET	
	TX (MHz)	LOCAL (MHz)	TX (MHz)	LOCAL (MHz)
CH 01	902.200	936.700	926.000	891.500
CH 02	902.400	936.900	926.200	891.700
CH 03	902.600	937.100	926.400	891.900
CH 04	902.800	937.300	926.600	892.100
CH 05	903.000	937.500	926.800	892.300
CH 06	903.200	937.700	927.000	892.500
CH 07	903.400	937.900	927.200	892.700
CH 08	903.600	938.100	927.400	892.900
CH 09	903.800	938.300	927.600	893.100
CH 10	904.000	938.500	927.800	893.300